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AQUATIC BIOTA AND ABIOTA OF THE LITTLE POWDER RIVER AND ANTELOPE CREEK IN THUNDER BASIN NATIONAL GRASSLAND, WYOMING

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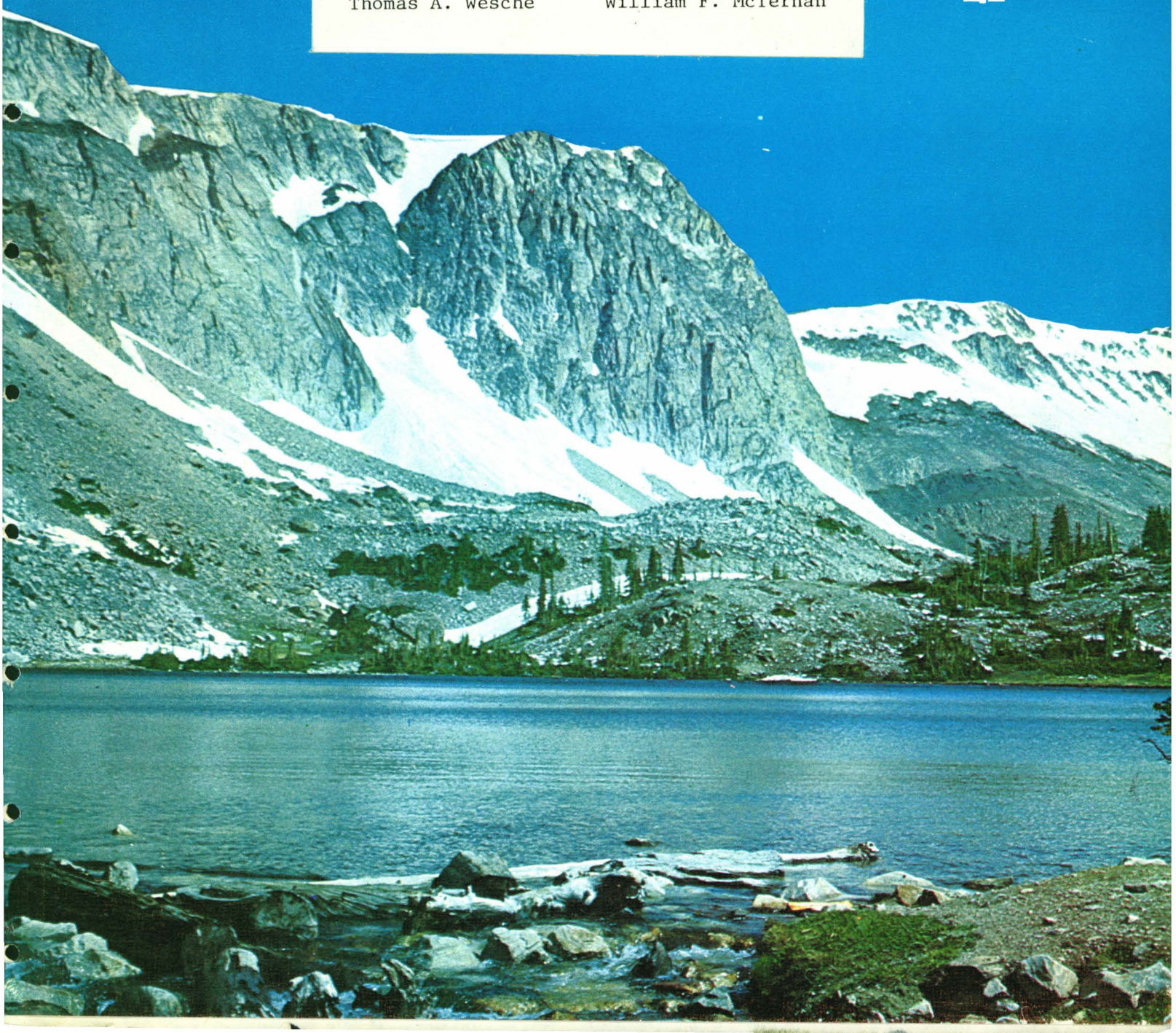

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Water Resources Research Institute
University of Wyoming

Completion Report
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U.S. Department of Agriculture
Rocky Mountain Forest and Range Experiment Station
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On

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ABSTRACT

In light of proposed coal development and as little such study has been undertaken in previous years, the objective of this investigation has been to continue developing baseline data on the aquatic biota and abiota of the Little Powder River through Thunder Basin National Grassland and to initiate such studies on Antelope Creek, the headwater of the Cheyenne River.

Both study streams are relatively shallow, meandering, low-gradient rivers characterized by wide, pastoral floodplains dotted with cottonwood trees, intermittency, sand and muck substrates and high summer water temperatures. The fish fauna is predominated by cyprinid (minnow) species, including sand shiners, fathead minnows, plains minnows and flathead chubs. Plains killifish are also abundant on Antelope Creek. Neither stream supports a viable fishery, the only game fish present being black bullheads and green sunfish. The invertebrate communities sampled are characterized by low diversity and generally large seasonal variations in abundance (lowest in spring or early summer, highest in fall and winter). The predominant forms collected include Diptera larvae, beetle larvae (Dubiraphia sp.), snails, clams, oligocheates and mayfly nymphs (Caenis sp.).

Water quality data generally corroborated data collected for other ongoing Eastern Powder River basin studies. Generally speaking, the waters of the Little Powder and Antelope Creek are moderately mineralized, well-buffered and hard.

Trace elements were present only in insignificant concentrations. No significant problems were indicated during this program.

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CHAPTER I

INTRODUCTION

Increasing state, regional, and national interest is presently being shown in the development of the sub-bituminous coal deposits underlying northeastern Wyoming. A portion of these deposits lie on or in the near vicinity of Thunder Basin National Grassland, administered by the U. S. Forest Service. At present, land use in this area is based primarily upon agriculture. However, it is anticipated that such use will probably be changing in the future as development of mineral resources proceeds. As this occurs, both the terrestrial and aquatic environments of the area will be affected, either directly or indirectly.

In past years, little definitive study has been directed toward the aquatic communities existing in the ephemeral, intermittent and perennial stream channels which drain Thunder Basin lands. Without such data, the ability of Forest Service personnel to determine and implement suitable management policies for these lands is reduced. Thus, the objective of this study has been to continue to develop such necessary baseline information by inventorying and evaluating the native benthic fauna, fish populations and water quality of the Little Powder River as it flows through the Thunder Basin National Grassland in Campbell County, Wyoming and to initiate such studies on Antelope Creek (Cheyenne River) in northern Converse County.

CHAPTER II

METHODS AND MATERIALS

Physical

The two reaches of the Little Powder River and three reaches of Antelope Creek investigated during this study were selected by personnel of the U. S. Forest Service and the principal investigators. Criteria applied for site selection were:

1) location within the boundaries of Thunder Basin National Grassland;
2) representation of other reaches of the Little Powder River in the Grassland;
3) accessability.

Baselines were surveyed along one streambank of each study site, with marker stakes being placed at five-foot intervals. These baselines were then used to map the surface area of the stream and also for sample location purposes. Mapping was conducted by measuring the distance from each stake, perpendicular to the baseline, to the stream edge. Survey techniques were also employed to determine the channel slope.

At each sampling time at each site, a discharge measurement was made following standard U.S.G.S. procedure, as described by Corbett, 1962. Velocity measurements were taken at one-foot intervals across the channel at the 0.6 depth using a Price current meter.

Drainage basin characteristics of the Little Powder River and Antelope Creek above the sampling locations were measured from 1:250,000

U. S. Army Map Service topography maps. The drainage area in square miles was determined by planimetric techniques using a Keuffel and Esser Compensating Polar Planimeter, while total stream length, including all perennial, intermittent and ephemeral channels, was measured with a Keuffel and Esser Map Measurer. Drainage density for the basin was then computed by dividing the total stream length (in miles) by the drainage area (in square miles). The Strahler method was used to determine stream order (Chorley, 1969). In this method, unbranched streams are numbered 1, streams with two or more tributaries rated as 1 are numbered 2, streams with two or more tributaries rated as 2 are numbered 3 and so on.

U.S.G.S. streamflow records for the Little Powder River and Antelope Creek were obtained from, 1973 Water Resources Data for Wyoming: Part 1. Surface Water Records.

Biological

Fisheries

Fish population sampling was conducted at the two Little Powder River study sites on June 24, 1975 and at the three Antelope Creek sites on June 23 and 25, 1975. All collections were made using 25 and 50 foot nylon seines having a depth of four feet and a 0.1875 inch mesh size. Electrofishing techniques could not be employed as the turbid water conditions encountered would have hampered the recovery of stunned fish due to poor visibility. For each fish collected, total length was measured to the nearest 1.0 millimeter and weight was recorded to the nearest 1.0 gram. To avoid misidentification of juvenile forms, primarily of minnow species (Family Cyprinidae), representative

individuals were preserved in 95 percent alcohol and transported to Laramie for verification using the keys developed by Baxter and Simon, 1970.

Fish population estimates were attempted at each site using the DeLury Removal Method (DeLury, 1947 and 1951). This procedure involved the following steps:

1. The study area was blocked off using natural barriers and seines to prevent escapement from or recruitment to the population.
2. Three seine hauls, each covering the entire enclosed area, were made, with the fish from each haul being placed in a separate "live car" (holding pen).
3. Treating each haul separately, all fish were identified, enumerated, measured and weighed.
4. A graph was then constructed using the Y-axis as the catch for each seine haul and the X-axis as the cumulative catch previous to a given seine haul. This is based on the assumption that as the number of seine hauls increases and the cumulative catch increases, the number of fish per haul will decrease.
5. Following this procedure, the data from the three seine hauls at a particular site were plotted and a line was fitted to these points using linear regression. The estimated number of fish at the site was then the point on the X-axis where this line intercepts it.
6. As the surface area and length of each sample site were measured, estimates were then placed on a numbers per surface

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5. Following this procedure, the data from the three seine hauls at a particular site were plotted and a line was fitted to these points using linear regression. The estimated number of fish at the site was then the point on the X-axis where this line intercepts it.
6. As the surface area and length of each sample site were measured, estimates were then placed on a numbers per surface

acre and per stream mile basis for sake of comparison. With the weight data collected, standing crop estimates were also placed on a pounds per surface acre and per stream mile basis.

To allow additional comparisons to be made of the community structure of the fish populations present, the Shannon Index of Diversity, as described by Odum (1971), Wilhm (1967) and Wilhm and Dorris (1968), was applied to the data from each site. This index, based upon the formula

$$\bar{H} = -\Sigma \left[\left(\frac{ni}{N}\right) \log \left(\frac{ni}{N}\right)\right]$$

where $\bar{H}$ = Shannon index of general diversity

ni = importance value for each species

N = total of importance values

represents the wealth of individual types of organisms present (i.e., the number of different types and the number of each type present).

Benthic Invertebrates

Bottom fauna samples were collected at the Little Powder River study sites on four dates: April 24, 1975; June 24, 1975; October 7, 1975; and January 14, 1976. Sampling on Antelope Creek was conducted on May 7-8, June 23-25, October 6-8, 1975 and January 13-15, 1976. On each date, six samples were taken from each site. Random number tables were employed to select sampling locations with one number being selected to determine the baseline marker stake at which the sample would be taken while a second number determined the sampling distance from the stream bank.

Due to the nature of the substrates present, all bottom samples were taken with an Eckman dredge, a spring-operated, jaw type sampler

especially designed for use in soft mud, muck and ooze substrates. Each sample encompassed an area of 0.25 square feet (0.023 m^2). Welch, 1948, discusses the use and operation of this sampler in greater detail.

All bottom fauna samples were transported live back to Laramie and immediately washed and screened. The detritus remaining in the screen was placed in white enamel pans and, using a 2X magnifying lamp, the invertebrates present were removed ("picked") and preserved in vials containing 95% alcohol.

The benthic invertebrates were identified to the lowest taxonomic level possible using available keys (Pennak, 1953; Walker, 1953; Ward and Whipple, 1959; Usinger, 1973). The number of each taxonomic type present in each sample was then enumerated and the biomass measured to the nearest milligram (mg) using a Mettler analytical balance. Immediately prior to weighing, all organisms were placed on filter paper and dried at room temperature for 24 hours. Thus, all weights were recorded as "air-dried" weights.

To allow comparisons of relative abundance to be made between both study sites and sampling times, bottom fauna data were placed on a numbers per 0.1 square meter and milligrams per 0.1 square meter basis. Also, Shannon Species Diversity Index values ($\bar{H}$) were calculated for each site at each time using the formula previously listed in this Chapter to facilitate comparisons of benthic community structure on both a numbers and biomass per 0.1 m^2 basis. To do this, $\bar{H}$ values were computed for each individual sample and these were then averaged to obtain the index number for a given study site at a given sampling time. Kruskal-Wallis Rank-Sum tests, as described by Dixon and Massey, 1969

and Sokal and Rohlf, 1969, were then used to determine if statistically significant differences existed between $\bar{H}$ values for the study sites and sampling times.

Water Quality

Water quality samples were collected during biological testing at each field station, chemically stabilized (where necessary) and transported to Laramie for processing at the Wyoming Department of Agriculture Chemical and Bacteriological Laboratory. All field and laboratory methods for sample handling, preparation and analysis were in compliance with currently recommended methods (APHA, 1971 and EPA, 1974).

Table 1 presents the chemical constituents monitored during the continuing program at the Little Powder River Stations as well as for this initial effort at the Antelope Creek stations. Three general categories of chemical constituents were monitored at each of the stations sampled. These were:

1) commonly occurring cations and anions;
2) nutrients and organic indicators;
3) trace metals and elements.

Chemical balances between cations and anions were determined following analysis. These determinations "typed" each collected sample as to the total amount of dissolved material, the individual ions present and the relative importance of each ion in the solution at the time of collection.

Nutrient and organic concentrations are generally indicative of recently received waste loads. The wastes can reach the stream either from point discharges or from non-point runoff. Other sources for some

of these compounds include some of the blasting preparations used in mining and natural drainage. This current effort was designed to collect background data for conditions assumed to be natural to the drainages.

Trace metals and elements, as the name implies, are generally found in waters in minute concentrations. The ability of a ground water source contributory to a stream to solubilize and transport these materials is related to pH, contact time, valency, the presence of various optimum strata and other currently unquantified complexities. Mining or similar activity in an area can theoretically create more conditions for these processes to occur as more surface area is exposed to chemical and physical reactions. This investigation sought to establish baselines against which the effects of future development in the area could be gauged.

TABLE 1

Chemical Constituents
Little Powder River and Antelope Creek

Calcium	Alkalinity	Fluoride
Magnesium	Ammonia	Iron (total)
Sodium	Total Kjeldahl Nitrogen	Lead
Potassium	Nitrite	Manganese
Carbonate	Phosphate (PO_4)	Mercury
Bicarbonate	Suspended Solids	Nickel
Sulfate	Total Dissolved Solids (TDS)	Selenium
Chloride	Total Solids	Silver
Nitrate	Arsenic	Zinc
Fluoride	Barium	Cyanide
Conductance	Boron	MBAS
COD	Cadmium	Phenol
pH	Copper	Oil and Grease
Turbidity	Chromium (hex)	Sulfides
Hardness		

CHAPTER III

DESCRIPTION OF STUDY AREAS

Little Powder River

The Little Powder River is one of only several perennial streams occurring in Campbell County of northeastern Wyoming (Figure 1). The topography is dominated by plains, low lying hills and table lands to the east with rough hills and gentle mountain ridges forming the west boundary of the basin. The Little Powder River is a major tributary of the Powder River within the Yellowstone River Basin of Wyoming. The headwaters rise in the Rawhide drainage (elevation 4800 feet MSL) immediately north of Gillette, Wyoming, and flow 88 miles to its confluence with the Powder River (elevation 3600 feet MSL) in southeast Montana. The total drainage area of the basin is 1,755 square miles.

The Little Powder River basin can be characterized primarily as a semiarid natural short grass plains area (average annual precipitation approximately 14 inches). Major vegetation types within the basin include: big sage brush (Artemisia tridentata), silver sage brush (Artemisia cana), black greasewood (Sarcobatus vermiculatus), ponderosa pine (Pinus ponderosa), plains cottonwood (Populus sargentii), and prairie grasses (Spartina pectinata, Deschampsia caespatesia, Elymus sp., and Agropyron sp.). (Final Environmental Impact Statement, Eastern Powder River Coal Basin of Wyoming, 1974).

Coincident with this natural setting, major land uses in the past have included: 1) grazing lands for livestock; 2) production of native

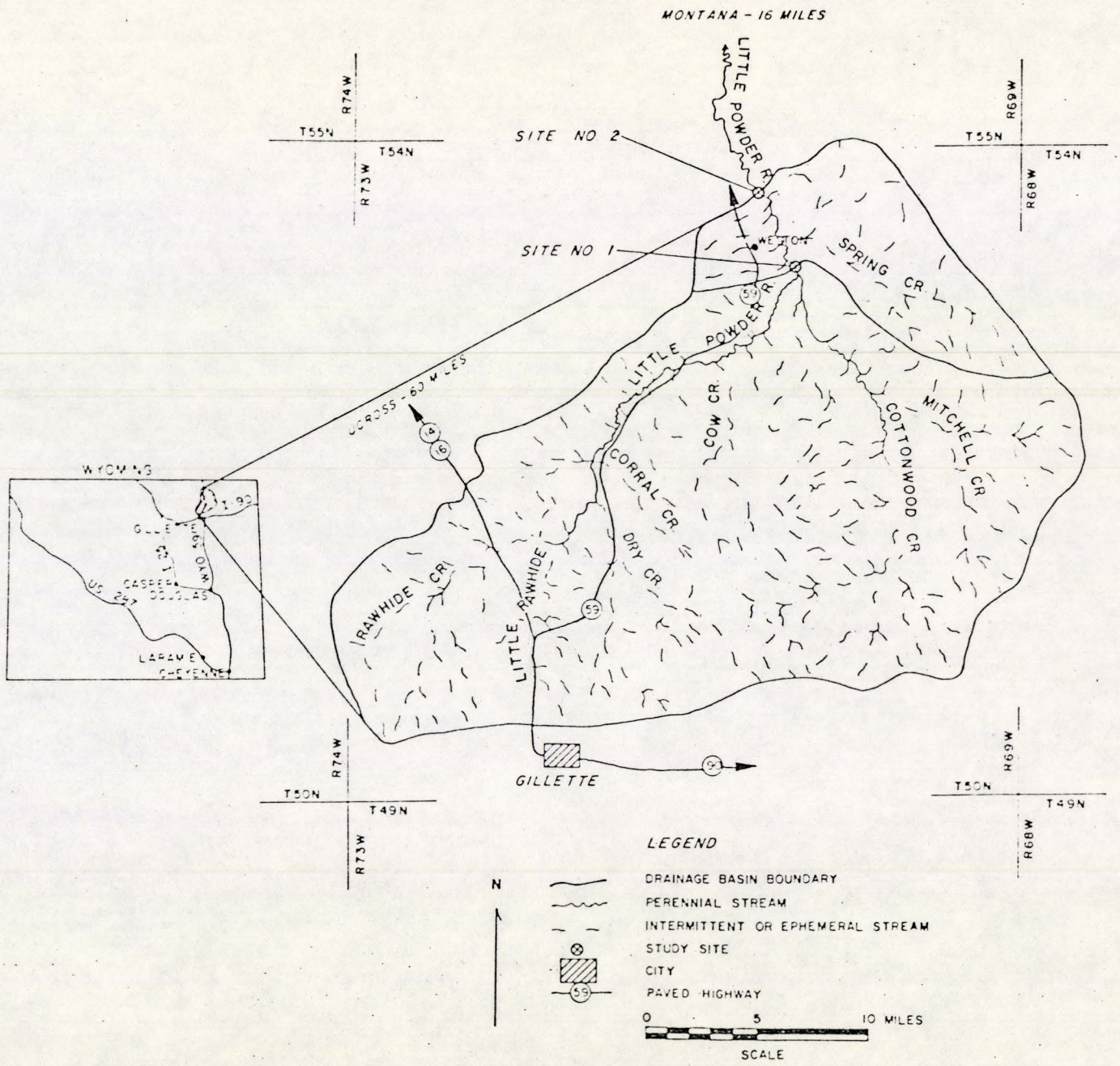

Figure 1. Little Powder River Drainage Basin.

hay; and, 3) wildlife habitat for deer, pronghorn antelope and upland game birds. At present, coal development is being initiated in the upper basin by the AMAX Coal Company and the Carter Oil Company. Also being discussed are projects for water storage development. Figure 2 illustrates the drainage basin and the beginnings of the development.

The Little Powder River lies in the Fort Union Formation, tertiary rock of the Paleocene era. The formation is composed of three members:

1) The Tullock Member (lowermost)--950 to 1,300 feet thick--light gray to tan, even bedded sandstone (massive to thin); dark gray and brown siltstone; shale and carbonaceous shale; thin coal beds.

2) The Lebo Shale Member (middle)--1,700 to 2,800 feet thick where undifferentiated from the Tongue River Member--mostly medium and dark gray, fine-grained to conglomeratic sandstone; brownish carbonaceous shale; thin to thick coalbeds.

3) The Tongue River Member (uppermost)--800 feet thick--interbedded light gray, fine-grained sandstone; siltstone; sand; shale; coalbeds.

The coalbeds in the Tullock Member are thin and parted. However, the thick, persistent coalbeds located near the top of the formation in the eastern part of the basin are suitable for strip mining. (Final Environmental Impact Statement, Eastern Powder River Coal Basin of Wyoming, 1974). Oil and gas are other mineral resources found in the vicinity of the Little Powder River.

Streamflow records for the Little Powder River basin, as measured at U.S.G.S. Gage Station No. 06324970 located 20 miles north of Weston, Wyoming and five miles south of the Wyoming-Montana border, indicate that spring runoff normally occurs during late April, May and early June. A maximum discharge of 1000 cfs (cubic feet per second) was measured

Figure 2. Little Powder River Drainage Basin, June, 1975.
Top: Beginning of coal development in the upper basin.
Bottom: Study Sites No. 1 (left) and No. 2 (right).

on January 17, 1974 while periods of no flow were recorded during July and August of 1973. During the remainder of the year, discharges normally remain below 10 cfs (U. S. Department of the Interior, 1974).

The study area was limited to the five mile section of the stream running across the southwest corner of the Thunder Basin National Grassland in Campbell County, Wyoming. During the 1974 field studies three sites were sampled (See, Wesche, Kerr and Baldridge, 1975). However, in 1975 the middle site at Soda Well was deleted, leaving the following two stations:

No. 1) T 54 N, R 70 W, S 32--on the Loral Leaf Ranch owned by Mr. Frank Ray, one-quarter mile below the confluence of Cottonwood Creek near the south boundary of Thunder Basin at an elevation of 3,730 feet above msl. (See Figures 1 and 2.)

No. 2) T 54 N, R 70 W, S 7 and T 54 N, R 71 W, S 12--on the Norfolk Ranch at the west boundary of Thunder Basin at an elevation of 3,670 feet above msl. (See Figures 1 and 2.)

Site No. 1

Above this site, the Little Powder River basin encompasses 472 square miles and is drained by 406 miles of perennial and intermittent stream channels. Drainage density is 0.86. In this area, as well as at Site No. 2, the Little Powder is a fifth order stream.

Site No. 1 was a 340-foot long straight reach covering 4530 square feet. Hydraulically, this stream section was quite homogenous, with stream widths varying only from 12 to 13 feet, while over 85 percent of the surface area was at least 1.0 foot in depth. Streamflow at the sampling times ranged from 8.9 cfs in June down to zero flow in October.

Due to the flat gradient of the section (3.52 feet per mile), the substrate was composed of inorganic muck and fine sand, sediments which had settled out of the water. This, in conjunction with the steep streambanks which were present (range, 0.2:1 to 2.6:1), made access to and movement in the channel quite difficult during sample collection.

Small amounts of filamentous green algae were in evidence at Site No. 1, while along the streambanks and on the floodplain adjacent to the channel, grasses, sedges, sage brush, greasewood and cottonwood trees were observed. While sampling here, mule deer, ring-necked pheasants and sharp-tail grouse were seen by the investigators.

Site No. 2

Above Site No. 2, the Little Powder drains an area of 551 square miles which contains a total of 469 miles of perennial and intermittent channels. Drainage density of the basin is 0.85.

Site No. 2 was a relatively straight stream reach 270 feet long having a surface area of 5,420 square feet. Due to its steeper stream gradient (9.50 feet per mile) and greater channel widths (up to 23 feet), water depths at Site No. 2 were somewhat shallower than those at Site 1, while mean velocities ranged higher. Approximately 60 percent of the surface area had water depths of less than 1.0 foot. The substrate composition at Site 2 was found to be more diverse than that at Site 1. Along the thalweg in the upstream half of the study section, areas of fine gravel were present. The remainder of the substrate was of inorganic muck and sand. Bank slopes varied substantially at this site, ranging from 0.5:1 to 7.5:1. Streamflow at the sampling times ranged from 16.2 cfs in April down to zero flow in October.

As at Site No. 1, small amounts of filamentous green algae were observed. Grasses and sedges, interspersed with wild rose, grew along the streambanks, while the adjacent floodplain was primarily covered with grasses and scattered cottonwood trees. Deer and racoon tracks were abundant in the area while evidence of beaver activity was found at the upper end of the section.

Antelope Creek

The headwaters of Antelope Creek rise on the east side of Pine Ridge near the Converse County-Natrona County boundary line in east-central Wyoming and flow intermittently 56 miles to the east before confluencing with the Dry Fork of the Cheyenne River to form the Cheyenne River near Dull Center (Figure 3). From this point, the Cheyenne flows easterly out of Wyoming to central South Dakota, where it joins the Missouri River. In Wyoming, the Cheyenne drains a total of 6,907 square miles of land (Person, 1939) whose elevation ranges from approximately 3,600 feet above msl at the state line to over 6,000 feet above msl at the headwaters.

The Antelope Creek basin can be characterized as semiarid rangeland dominated by big sage brush/shortgrass plains, and low-lying hills and tablelands, dotted with occasional isolated uplands, breaks, knobs and ridges. The stream has a wide, flat, floor and a broad floodplain covered in many areas with stands of plains cottonwood (Populus sargentii) and willow (Salix sp). Average annual precipitation is approximately 12-14 inches per year. (Final Environmental Impact Statement, Eastern Powder River Coal Basin of Wyoming, 1974.) Figure 4 provides general views of the basin.

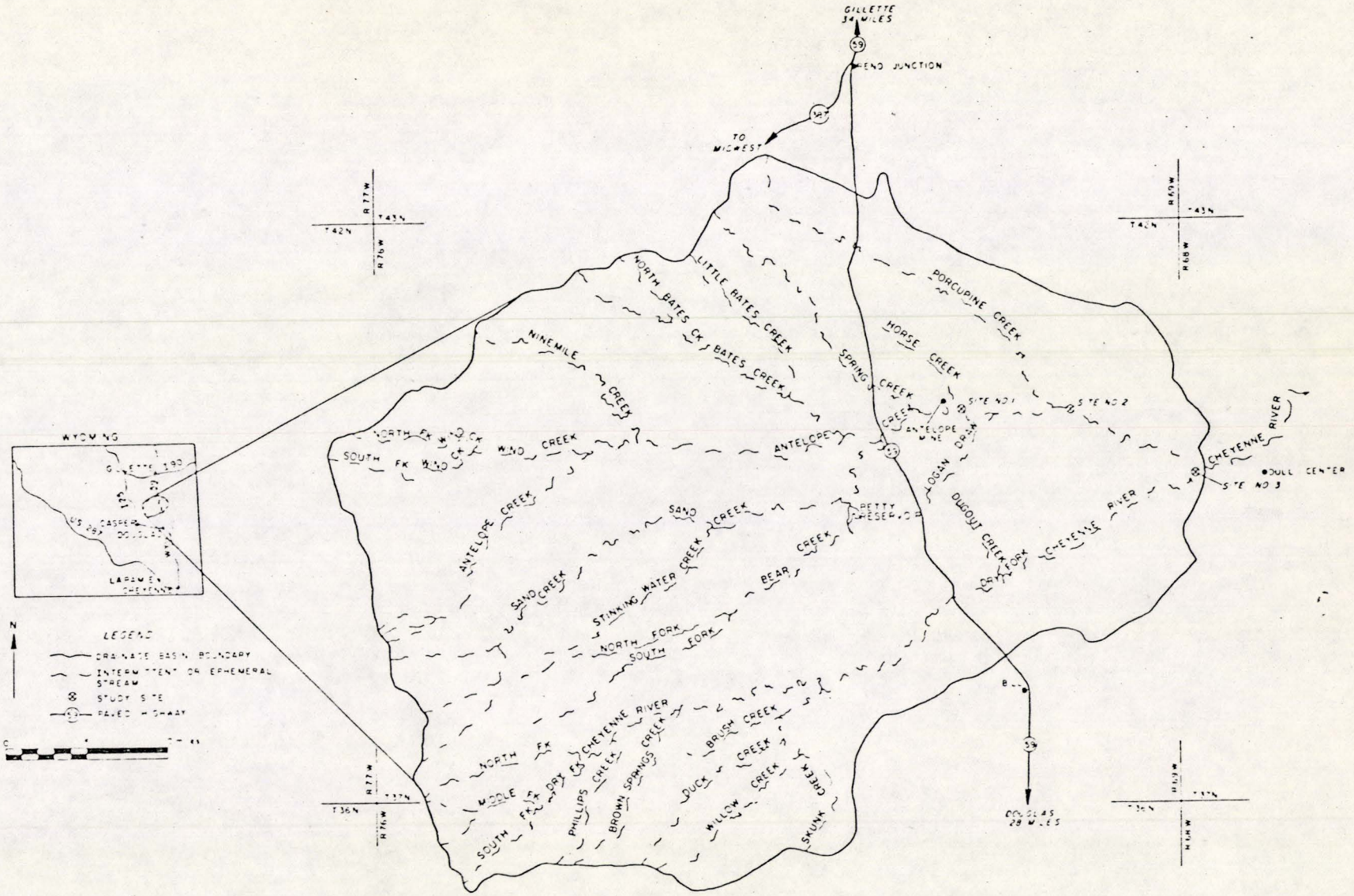

Figure 3. Antelope Creek Drainage Basin.

Figure 4. Antelope Creek Drainage Basin, 1975.
Top: Rochelle Hills near Study Site No. 3, June.
Bottom: Floodplain between Study Sites No. 2 and 3, April.

Historic land uses in the Antelope Creek drainage are similar to those described for the Little Powder basin, namely, livestock grazing, hay production and wildlife habitat. In recent years oil production has been on the increase as evidenced by the many new roads and operating wells which dot the landscape. The basin is also underlain by rich deposits of sub-bituminous coal and, while full-scale development of the resource has not yet begun, it can be foreseen in the near future. In the past, limited amounts of coal have been produced at the Antelope Mine, while at present, the Peabody Coal Company holds federal leases in the basin and have proposed opening the Rochelle Mine sometime in the future.

Streamflow records for Antelope Creek are non-existent. The nearest U.S.G.S. gage station (No. 06386500) is located approximately 65 miles downstream from the lowest study site on the Cheyenne River proper near Spencer, 5 miles west of the South Dakota border. These records indicate that spring runoff normally occurs in April and May, with the maximum discharge of record being 16,000 cfs on May 27, 1962. During the late summer and early fall, periods of zero flow are quite common. From 1948 to 1974, the average discharge was 58.2 cfs (U.S. Department of the Interior, 1974).

Three study sites were investigated on Antelope Creek, all within the boundaries of the Grassland and accessible by vehicle. These sites were:

No. 1) T 41 N, R 71 W, Section 36--below the Antelope Mine at the junction of the Irwin Road and Hilight Road.

No. 2) T 41 N, R 70 W, Section 36--above the Irwin Ranch on the Irwin Road and below the mouth of Porcupine Creek.

No. 3) T 40 N, R 68 W, Section 20--near the Fiddleback Ranch just above the river crossing on the Rochelle Hills Road and immediately below the confluence of Antelope Creek and the Dry Fork of the Cheyenne River.

Figure 3 shows the location of these sites while Figure 5 depicts the habitat present at each.

Site No. 1

Above this site, the Antelope Creek basin encompasses 808 square miles and is drained by 846 miles of intermittent stream channels. Drainage density is 1.05. At this location, as well as at Sites 2 and 3, Antelope Creek is a 5th order stream.

Site No. 1 was a 300-foot-long straight reach varying in width from 26 to 53 feet and covering approximately 12,200 square feet. Water depths ranged up to 2.0 feet in the upper 150 feet of the section, while in the lower half, no depths exceeded 1.0 feet. Streamflow at the sampling times ranged from 14.1 cfs in May down to zero in both October and January. Due in part to the exceptionally flat gradient of the section (0.35 feet per mile) the substrate was composed primarily of silt and fine sand.

Aquatic vegetation was quite dense at Site No. 1, being composed primarily of filamentous green algae and Chara sp. In fact, during the June fish sampling operation, these heavy growths hampered seining to such a degree that accurate population estimates could not be made. Muskrats, mule deer and antelope were observed at this site during our sampling visits.

Figure 5. Antelope Creek Study Sites, 1975.
Top: Study Site No. 1, June.
Bottom: Study Sites No. 2, May (left) and No. 3, June (right).

Site No. 2

The Antelope Creek watershed above Site No. 2 covers 975 square miles and is drained by a total of 981 miles of stream channels. Drainage density is quite low at 1.01.

In terms of channel hydraulics and morphometry, the 300-foot-long, low-gradient reach (less than 1.0 foot per mile) showed little diversity. In June, wetted channel widths varied from 30 to 46 feet with a surface area of 11,500 square feet. Water depths throughout the section ranged up to 2.0 feet while velocities were less than 0.50 feet per second. Discharge ranged from 10.6 cfs in May down to zero in October. It is of interest to note that during the October sampling, Site No. 2 was completely dry. Hence, sampling had to be carried out several hundred feet downstream.

As at Site No. 1, the substrate consisted of silt and sand. However, at Site 2 no dense growths of aquatic vegetation were encountered. Riparian vegetation consisted primarily of thick stands of willows with scattered cottonwood trees. Willows were not abundant at either Site 1 or 3, as shown in the photographs in Figure 5. During the course of the study, numerous waterfowl, mule deer and antelope were observed in the vicinity of Site No. 2. Racoon tracks and beaver activity were also noted.

Site No. 3

Above Site No. 3, Antelope Creek drains an area of 1496 square miles containing 1486 miles of intermittent and perennial channels. As at Sites 1 and 2, drainage density is low, 0.99.

Of the three sites, No. 3 (300 feet long) had the greatest wetted width (range, 48-57 feet) and surface area (20,400 square feet) and

had the shallowest depths (less than 1.0 feet throughout the area). While the gradient was the steepest here of all the sites, it was still exceptionally flat at 0.7 feet per mile. The substrate was primarily soft mud, with scattered areas of fine sand. Flow on the sampling dates ranged from 9.9 cfs in May down to 0.5 cfs in January.

As at Site No. 2, aquatic vegetation was sparse throughout the year. Riparian vegetation, consisting primarily of various grasses, sedges and cottonwood trees, was very lush in June, as shown on Figure 5. This, together with the proximity of the Rochelle Hills (Figure 4), easily made Site No. 3 the most esthetically pleasing of the three study areas. Mule deer and antelope were quite abundant at this location.

CHAPTER IV

RESULTS

Biological

Fisheries

During the June, 1975 sampling on the Little Powder River, eleven species of fish, representing four families and two orders, were collected. One species collected in 1974, the goldeye, was not found in 1975, while one new species, the plain minnow, was added. On Antelope Creek, 10 species, representing 3 orders and 5 families, were sampled in 1975. Speciation for the two study streams was quite similar, with all of the Antelope Creek species, with the exception of the plains killifish, being found in the Little Powder River. Two Little Powder species, the river carpsucker and northern redhorse, were not collected at Antelope Creek. The taxonomic classification of all fishes sampled appears in Table 2.

Little data is available from the literature and the files of the Wyoming Game and Fish Department concerning the fish fauna of the two study streams. The only references found were those of Baxter and Simon, 1970, who reported collecting eleven species at three locations on the Little Powder and eight species in the Cheyenne River (Antelope Creek). Table 3 lists these species and the streams from which they were collected. Of these, WRRI has collected all but two, channel catfish and mountain suckers. For the Little Powder River, the WRRI study has identified three additional species, goldeye, carp and northern

TABLE 2

TAXONOMIC CLASSIFICATION OF FISHES COLLECTED FROM THE LITTLE POWDER RIVER (1974 AND 1975) AND ANTELOPE CREEK (1975).

CLASS - OSTEICHTHYES (bony fishes)
SUBCLASS - ACTINOPTERYGII (ray-finned fishes)

Order	Family	Genus	Species
Clupeiformes	Hiodontidae (mooneyes)	Hiodon	alosoides (Rafinesque) (goldeye)
Cypriniformes	Cyprinidae (minnows)	Cyprinus	carpio (Linnaeus) (carp)
		Hybopsis	gracilis (Richardson) (flathead chub)
		Rhinichthys	cataractae (Valenciennes) (longnose dace)
		Notropis	stramineus missuriensis (Cope) (sand shiner)
		Pimephales	promelas (Rafinesque) (fathead minnow)
		Hybognathus	placitus (Girard) (plains minnow)
	Catostomidae (suckers)	Carpiodes	carpio (Rafinesque) (river carpsucker)
		Moxostoma	macrolepidotum (Lesueur) (northern redhorse)
		Catostomus	commersoni (Lacépède) (white sucker)
	Ictaluridae (North American catfishes)	Ictalurus	melas (Rafinesque) (black bullhead)
Perciformes	Centrarchidae (sunfishes)	Lepomis	cyanellus (Rafinesque) (green sunfish)
Cyprinodontiformes	Cyprinodontidae (killifishes)	Fundulus	kansae (Garman) (plains killifish)

TABLE 3

FISH SPECIES OF THE LITTLE POWDER AND CHEYENNE RIVERS
AS REPORTED BY BAXTER-SIMON, 1970*.

Genus	Species	Common Name	Stream
[1]Hybopsis	gracilis (Richardson)	Flathead Chub	LPR, CR
[1]Rhinichthys	cataractae (Valenciennes)	Longnose Dace	LPR
[1]Notropis	stramineus missuriensis (Cope)	Sand Shiner	LPR, CR
[1]Hybognathus	placitus (Girard)	Plains Minnow	LPR, CR
[1]Pimephales	promelas (Rafinesque)	Fathead Minnow	LPR, CR
[1]Catostomus	commersoni (Lacépède)	White Sucker	LPR
Catostomus	platyrhynchus (Cope)	Mountain Sucker	LPR
[1]Carpiodes	carpio (Rafinesque)	River Carpsucker	LPR, CR
[1]Ictalurus	melas (Rafinesque)	Black Bullhead	LPR, CR
Ictalurus	punctatus (Rafinesque)	Channel Catfish	LPR
[1]Lepomis	cyanellus (Rafinesque)	Green Sunfish	LPR, CR
[1]Fundulus	kansae (Garman)	Plains Killifish	CR

LPR = Little Powder River
CR = Cheyenne River

*from Wyoming Fishes, Baxter-Simon, 1970.

[1]Species collected by WRRI, 1974 and/or 1975.

redhorse, while for the Cheyenne drainage, white suckers, carp and longnose dace have been added.

Little Powder River. Ten species of fish were collected at Site No. 1 (as compared to 7 in 1974) but only three were found at Site No. 2 (11 in 1974). Species composition and length-weight data are reported in Table 4, while standing crop estimates are presented in Table 5.

Sand shiners remained the predominant species at both sites on a numbers basis, representing 60.8 percent of the population at Site No. 1 (60.8 percent in 1974 also) and 78.4 percent at No. 2 (75.7 percent in 1974). On a weight basis, however, this small minnow species comprised less than 30 percent of the populations. At Site No. 1, white suckers again were the predominant species on a biomass basis, comprising 31.8 percent of the total (47.6 percent in 1974), while at No. 3, black bullheads accounted for 57.1 percent, by weight.

1975 standing crop estimates for the two study sites were below 1974 levels. At Site No. 1, fish populations remained the densest, with estimates of 1885 fish and 46.6 pounds per surface area (1974 values were 2971 and 66.8, respectively). Population levels were more drastically reduced at Site No. 3, with standing crops estimated at only 222 fish and 0.7 pounds per acre, down from 2773 fish and 25.6 pounds in 1974. While these reductions appear to be quite dramatic, it must be remembered that when dealing with fish populations, we are involved with highly mobil organisms which can move into and out of a given stream reach in a very short time. Thus, at this point in time, random fish movement and natural fluctuation of population levels can be considered the most plausible explanations for these declines. On the positive side, all 1974 species were represented in the 1974 sample, with the

TABLE 4

LENGTH-WEIGHT DATA FOR FISH SPECIES COLLECTED FROM LITTLE POWDER RIVER IN JUNE, 1975.

Species	Number	Mean Length (mm)	Length Range (mm)	Mean Weight (g)	Weight Range (g)
		Site No. 1			
Black bullhead	21	64.3	36-217	12.1	1-160
Green sunfish	15	71.6	38-136	9.3	1-48
River carpsucker	2	277.5	240-315	282.0	164-400
Northern redhorse	2	175.0	110-240	71.5	13-130
White sucker	17	147.0	71-230	38.1	4-112
Plains minnow	7	84.3	62-117	7.0	3-16
Sand shiner	110	all less than 65 mm		0.9	---
Carp	1	84.0	---	8.0	---
Flathead chub	5	135.8	117-164	24.6	15-38
Fathead minnow	1	65.0	---	3.0	---
		Site No. 2			
Black bullhead	1	94.0	---	10.0	---
Sand shiner	11	37.2	29-50	0.6	---
Longnose dace	2	52.0	51-53	1.0	---

TABLE 5

STANDING CROP ESTIMATE FOR FISH SPECIES COLLECTED
ON THE LITTLE POWDER RIVER, JUNE, 1975.

Species	Site No. 1				Site No. 2			
	No./acre (No./mile)	% Numbers	lbs./acre (lbs./mile)	% Weight	No./acre (No./mile)	% Numbers	lbs./acre (lbs./mile)	% Weight
Black Bullhead	219 (355)	11.6	5.8 (9.5)	12.4	16 (39)	7.2	0.4 (0.9)	57.1
Green Sunfish	156 (254)	8.3	3.2 (5.2	6.9	0	0	0	0
River Carpsucker	21 (34)	1.1	13.0 (21.1)	27.9	0	0	0	0
Northern Redhorse	21 (34)	1.1	3.3 (5.4)	7.1	0	0	0	0
White Sucker	177 (288)	9.4	14.8 (24.2)	31.8	0	0	0	0
Plains Minnow	73 (118)	3.9	1.1 (1.8)	2.4	0	0	0	0
Sand Shiner	1146 (1860)	60.8	2.3 (3.7)	4.9	174 (423)	78.4	0.2 (0.6)	28.6
Carp	10 (17)	0.5	0.2 (0.3)	0.4	0	0	0	0
Flathead Chubb	52 (85)	2.8	2.8 (4.6)	6.0	0	0	0	0
Fathead Minnow	10 (17)	0.5	0.1 (0.1)	0.2	0	0	0	0
Longnose Dace	0	0	0	0	32 (77)	14.4	0.1 (0.2)	14.3
Totals	1885 (3062)	100.0	46.6 (75.9)	100.0	222 (539)	100.0	0.7 (1.7)	100.0

exception of goldeye (only one was collected in 1974).

Also, inspection of the Shannon diversity values in Table 6 shows that while species diversity declined at Site No. 3, improvement in community structure was found at No. 1.

As in 1974, only two species classified as game fish by the Wyoming Game and Fish Department were collected, black bullheads and green sunfish. A third such species, channel catfish, has been reported in the drainage by Baxter and Simon, 1970, but has not been collected by WRRI. Also, none of the species sampled in 1975 are classified as rare and endangered by WGFD or the U.S. Department of the Interior.

Antelope Creek. Species composition and length-weight data for the fish populations sampled at the 3 Antelope Creek study sites are presented in Table 7, while Table 8 contains the standing crop estimates. As noted earlier, population estimates could not be made at Site No. 1 due to the dense stands of aquatic vegetation present.

Overall, the fish populations of Antelope Creek are comprised primarily of minnow and killifish species, with smaller numbers of sunfish, bullheads and suckers. At Site No. 1, fathead minnows were the predominant species on both a numbers and weight basis (70.8 percent of total numbers and 35.4 percent of biomass), while at No. 2, plains killifish were the most abundant, comprising 44.8 percent of the weight. At Site No. 3, sand shiners contributed 68.1 percent of the fish numbers, while plains minnows were the predominant species by weight (61.7 percent).

Fish populations were quite dense at each site, with that at Site No. 3 being the most abundant (estimates of 4776 fish and 26.6 pounds per acre). Community structure was similar at all three sites,

TABLE 6

SHANNON SPECIES DIVERSITY INDEX VALUES ($\bar{H}$) FOR THE FISH POPULATIONS SAMPLED IN JUNE, 1975 ON THE LITTLE POWDER RIVER AND ANTELOPE CREEK (1974 VALUES IN PARENTHESES).

Little Powder River

	Site No. 1	Site No. 2
$\bar{H}$ (numbers basis)	0.591969 (0.538528)	0.284887 (0.445463)
$\bar{H}$ (biomass basis)	0.777320 (0.411384)	0.409399 (0.839926)

Antelope Creek

	Site No. 1	Site No. 2	Site No. 3
$\bar{H}$ (numbers basis)	0.384259	0.571854	0.401561
$\bar{H}$ (biomass basis)	0.725827	0.684531	0.459613

TABLE 7

LENGTH-WEIGHT DATA FOR FISH SPECIES COLLECTED FROM ANTELOPE CREEK IN JUNE, 1975.

Species	Number	Mean Length (mm)	Length Range (mm)	Mean Weight (g)	Weight Range (g)
		Site No. 1			
Black bullhead	2	159.0	130-188	75.5	33-118
Green sunfish	8	50.8	41-70	2.5	1-7
Sand shiners	72	all less than 65 mm		1.6	---
Plains killifish	2	55.0	47-63	1.5	1-2
Plains minnow	3	96.7	94-101	10.7	8-12
Flathead chub	3	100.7	86-120	9.7	7-14
White sucker	5	108.8	93-118	13.6	8-18
Fathead minnow	229	all less than 76 mm		1.0	---
		Site No. 2			
Green sunfish	10	55.0	36-95	5.3	1-23
Plains killifish	331	all less than 76 mm		1.3	---
Fathead minnow	202	all less than 76 mm		1.6	---
Sand shiner	128	all less than 65 mm		1.7	---
Plains minnow	61	84.0	44-107	6.8	---
Flathead chub	5	105.2	92-115	12.8	---
		Site No. 3			
Black bullhead	1	50.0	---	1.0	---
Green sunfish	5	40.8	35-50	1.0	---
Flathead chub	40	95.3	59-123	9.5	---
Plains minnow	375	---	48-106	7.2	---
Carp	1	120.0	---	26.0	---
Sand shiner	1178	---	34-67	0.9	---
Fathead minnow	12	---	45-58	2.1	---
Plains killifish	115	58.3	44-74	1.6	---
Longnose dace	1	51.0	---	1.0	---

TABLE 8

STANDING CROP ESTIMATE FOR FISH SPECIES COLLECTED ON ANTELOPE CREEK, JUNE, 1975.

Species	Site No. 1*		Site No. 2				Site No. 3			
	% Numbers	% Weight	No./acre (No./mile)	% Numbers	lbs./acre (lbs./mile)	% Weight	No./acre (No./mile)	% Numbers	lbs./acre (lbs./mile)	% Weight
Black Bullhead	0.6	23.3	0	0	0	0	3 (23)	0.1	0.01 (0.05)	<0.1
Breen Sunfish	2.4	4.1	45 (204)	1.4	0.5 (2.4)	3.4	14 (113)	0.3	0.03 (0.25)	0.1
Plains Killifish	0.6	0.5	1455 (6752)	44.8	4.2 (19.3)	28.8	318 (2610)	6.7	1.1 (9.2)	4.1
White Suckers	1.5	10.5	0	0	0	0	0	0	0	0
Plains Minnow	0.9	4.9	269 (1244)	8.3	4.0 (18.6)	27.4	1036 (8509)	21.6	16.4 (134.9)	61.7
Fathead Chub	0.9	4.5	23 (102)	0.7	0.7 (2.9)	4.8	111 (908)	2.3	2.3 (19.0)	8.6
Fathead Minnow	70.8	35.4	890 (4121)	27.4	3.1 (14.5)	21.2	33 (272)	0.7	0.15 (1.3)	0.6
Sand Shiner	22.3	17.8	564 (2612)	17.4	2.1 (9.8)	14.4	3255 (26,731)	68.1	6.4 (53.0)	24.1
Carp	0	0	0	0	0	0	3 (23)	0.1	0.2 (1.3)	0.8
Longnose Dace	0	0	0	0	0	0	3 (23)	0.1	0.01 (0.05)	<0.1
Totals	100.0	100.0	3246 (15,035)	100.0	14.6 (67.5)	100.0	4776 (39,212)	100.0	26.6 (219.05)	100.0

*Estimate not made due to dense vegetation.

with Site No. 1 having the highest diversity value on a biomass basis and No. 2 on a numbers basis (Table 6).

As on the Little Powder River, only two game fish species were collected, black bullheads and green sunfish. It is quite safe to say that as a sport fishery, Antelope Creek is rather poor. Neither species is highly regarded by sportsmen due to their small size and, during our travels up and down the stream, no anglers were ever observed. Also, none of the species present are classified as rare and endangered.

Biology of Species Collected.

Green Sunfish (Lepomis cyanellus). (From: Baxter and Simon, 1970; Scott and Crossman, 1973; Hunter, 1963.)

Adult Size: Approximately eight inches.

Life Expectancy: seven to nine years.

Range: Widely distributed in the U. S., from the Great Lakes to the Mexican Border and from the Alleghenies to the Rocky Mountains. In Wyoming, primarily in the northeastern counties and also in the North Platte, Big Horn and Niobrara river systems.

Preferred Habitat: Pools of small and medium sized streams. Sometimes abundant in small lakes, ponds and sloughs.

Feeding Habits: Carnivorous, feeding primarily on insects, molluscs and small fishes.

Spawning Habits: Individuals reach sexual maturity at two to three years of age. Spawning normally occurs during the spring and early summer (68 to 83°F) over substrates of mud, silt, sand or aquatic vegetation in pools having water depths

ranging from 1.5 to 18 inches. Eggs are deposited in a nest built by the male and hatch in three to five days. Members of the species are prolific spawners and often overpopulate their warm water habitats.

Comments: At the Little Powder River and Antelope Creek study sites, it appeared that spawning had occurred prior to the June sampling and the eggs had hatched. This was indicated by the number of fish in the 1.0 to 1.9 inch size group.

Black Bullhead (Ictalurus melas). (From: Baxter and Simon, 1970; Scott and Crossman, 1973; Forney, 1955; Wallace, 1967; Black, 1953.)

Adult Size: Average five to seven inches, but up to 15 inches.

Life Expectancy: Approximately nine years.

Range: From the East coast west to the Rocky Mountains and from Manitoba south to Tennessee. In Wyoming, found in all drainages east of the Continental Divide on the plains. Species can tolerate water temperatures to mid-90°F range and very low dissolved oxygen concentrations.

Preferred Habitat: Low gradient, turbid, warm-water streams and ponds.

Feeding Habits: Primarily carnivorous, including aquatic insects, snails, crustaceans and small fish. Also feed on plant material.

Spawning Habits: Spawning normally occurs during the spring and early summer (approximately 70°F) in shallow pool areas having substrates of mud, silt, sand or rooted aquatic vegetation. Each mating pair builds at least five nests, with approximately 200 eggs deposited in each. Eggs hatch

in five days and the fry are guarded by one or both parents. Members of this species are prolific spawners and often overpopulate their habitat unless intensively managed as a fishery.

Comments: At the Little Powder River study sites, it appeared that spawning had occurred prior to the June sampling and the eggs had hatched. This was indicated by the number of fish collected in the 1.0 to 1.9 inch size class.

Sand Shiner (Notropis stramineus missuriensis). (From: Baxter and Simon, 1970; Scott and Crossman, 1973; Minckley, 1973; Carlander, 1969; Starrett, 1951.)

Adult Size: Normally two to three inches.

Life Expectancy: Three to four years.

Range: Rocky Mountains east to the St. Lawrence drainage. In Wyoming, all drainages east of the Continental Divide, except the headwaters of the Madison and Yellowstone rivers in Yellowstone Park.

Preferred Habitat: Warm, perennial, sandy streams and sandy, shallow lakes with little rooted aquatic vegetation.

Feeding Habits: Omnivorous, including aquatic and terrestrial insects and diatoms.

Spawning Habits: Individuals normally become sexually mature at one year of age. Spawning occurs in the summer from June to August over sand and clean gravel areas. Each female produces from 250 to 3,000 eggs which are scattered over the stream substrate. No nest construction or parental care is known to occur.

Comments: Excellent forage species in Wyoming. No spawning activity or gravid specimens were noted during WRRI's 1974 collections. Ripe females were collected on Antelope Creek in June, 1975.

Fathead Minnow (Pimephales promelas). (From: Baxter and Simon, 1970; Markus, 1934; Simpson, 1941; Scott and Crossman, 1973; Wynn-Edwards, 1932.

Adult Size: Up to 3.5 inches.

Life Expectancy: Normally two years.

Range: Northwest Territory of Canada south to Mexico, east of the Rocky Mountains. In Wyoming, widespread and common in smaller streams, many ponds and some lakes east of the Continental Divide. Has been introduced into the Green River drainage.

Preferred Habitat: Cool and warm water, slow-flowing, weedy streams and shallow lakes and ponds. Common in many intermittent streams.

Feeding Habits: Primarily herbivorous, including algae, plankton and organic detritus. Also, small numbers of insects.

Spawning Habits: In more northerly climates, individuals reach sexual maturity at one year of age; however, in Iowa, it was found that fish hatched in May reach adult size and were spawning by late July. Spawning activity normally begins in spring or early summer when water temperatures reach 60°F. Males select and guard nests located in rocky or weedy areas (also under logs) of pools in one to three feet of water. Females then deposit up to 12,000

adhesive eggs which cling to the roof of the nest. The incubation period ranges from four to six days. During this phase of development, the male guards the eggs and agitates the water in the near vicinity of them. This agitation prevents silt accumulations, removes matabolic products and aerates the eggs.

Comments: At the Little Powder River and Antelope Creek study sites in June, examination of adult fish revealed that most spawning activity had already occurred, although several individuals, still gravid, were collected. This species serves as an excellent forage fish throughout the U. S.

Carp (Cyprinus carpio). (From: Baxter and Simon, 1970; Scott and Crossman, 1973.)

Adult Size: Seldom over 10 pounds in Wyoming.

Life Expectancy: Up to 20 years.

Range: Throughout U. S. In Wyoming, common at lower elevations in all river systems except the Snake and Niobrara rivers.

Preferred Habitat: Lakes, lagoons and quiet pools and backwaters of rivers.

Feeding Habits: Omnivorous. Species "roots" in bottom muds for insects, annelids, molluscs, crustaceans and vegetation.

Spawning Habits: Maturity is normally reached in three to four years for males, while for females, four to five years. Spawning occurs in the spring and early summer when water temperatures range from 63 to 82°F in the shallow, weedy areas of pools. Carp are extremely prolific, with large

females capable of producing up to several million adhesive eggs. No nests are built and no parental care is exhibited. Eggs are scattered over the bottom where they adhere to vegetation and incubate for three to six days before hatching.

Comments: During the June, 1974, sampling on the Little Powder, no gravid individuals were collected. Two explanations can be offered for this; either spawning had already occurred, or, the three individuals captured had not yet reached sexual maturity. Only one immature specimen was captured in 1975 on each study stream. This species is normally considered detrimental to game fish because their "rooting" while feeding increases turbidity and destroys vegetation.

Flathead Chub (Hybopsis gracilis). (From: Baxter and Simon, 1970; Olund and Cross, 1961; Cross, 1967; Scott and Crossman, 1973.)

Adult Size: Average five to seven inches. Up to 10 inches or more.

Life Expectancy: Several years.

Range: From the Northwest Territory of Canada south to Oklahoma and New Mexico. In Wyoming, common in all drainages east of the Continental Divide except the Madison, Yellowstone, Niobrara and South Platte river systems.

Preferred Habitat: Larger silty rivers. Seldom found in lakes and ponds.

Feeding Habits: Primarily carnivorous, including terrestrial and aquatic insects and small fish. Also some vegetation.

Spawning Habits: Species apparently spawns relatively late in summer when rivers are lower, warmer and the bottom more stable. No other information is available except that males become tuberculate in late summer.

Comments: Two of the four individuals collected from the Little Powder in June, 1974 were females in pre-spawning condition. Ripe females were collected in June, 1975 on Antelope Creek.

Longnose Dace (Rhinichthys cataractae). (From: Baxter and Simon, 1970; Kuehn, 1949; Simpson, 1941; McPhail and Lindsey, 1970; Scott and Crossman, 1973.)

Adult Size: Average three to four inches. Up to six inches.

Life Expectancy: Up to five years.

Range: Throughout U. S. In Wyoming, native to and common in all drainages but the Green and Little Snake River basins.

Preferred Habitat: Both small and large streams in riffle areas. Also found in lakes along rocky shorelines.

Feeding Habits: Primarily insectivorous, but also feed on small amounts of algae.

Spawning Habits: Spawning occurs in the spring and summer most probably in riffle areas over a gravel bottom. Each female normally produces from 200 to 1,200 adhesive eggs which cling to the substrate. No nest is built but one parent remains in the vicinity of egg deposition to guard them. At 60°F, eggs hatch in seven to ten days.

Comments: None of the fish collected were found to be gravid, indicating that spawning had already occurred or that the

specimens were juvenile fish. Few individuals were collected during June sampling, most probably due to the lack of gravel bottomed riffle areas which this species prefers.

White Sucker (Catostomus commersoni). (From: Baxter and Simon, 1970; Reighard, 1920; Simpson, 1941; Scott and Crossman, 1973; Campbell, 1935; Geen et al., 1966.)

Adult Size: Rarely over two pounds in Wyoming.

Life Expectancy: Up to 17 years.

Range: Rocky Mountains east to Atlantic seacoast and south from the Arctic Circle to southeastern U. S. In Wyoming, most common fish east of the Continental Divide. Also been introduced into Green and Little Snake River drainages.

Preferred Habitat: Common in a variety of habitats, from high mountain lakes to sluggish lowland streams. Avoids fast current.

Feeding Habits: Omnivorous. Feeds along stream bottom primarily for insects, but also for algae and other organic debris.

Spawning Habits: Individuals normally mature from three to four years of age. Spawning activity begins in spring and early summer when water temperatures reach 50°F in shallow water over sand or gravel substrates. During spawning the males become densely tuberculate. There is no deliberate construction of a nest but the activities of the adults create depressions in the substrate into which the female may deposit up to 50,000 eggs. The incubation period lasts approximately 14 days.

Comments: In June, it appears spawning had already occurred as no gravid adults were collected. This species serves as a good forage fish.

Northern Redhorse (Moxostoma macrolepidotum). (From: Baxter and Simon, 1970; Scott and Crossman; Meyer, 1962; Reed, 1962.)

Adult Size: Up to 20 inches and several pounds.

Life Expectancy: Reported up to 12 years.

Range: Montana and Saskatchewan east to Atlantic seacoast and south to Oklahoma. In Wyoming, species had previously been collected in the North Platte and lower Laramie Rivers, in the Belle Fourche, Tongue and Powder River drainages, and in the Big Horn River.

Preferred Habitat: Medium sized streams and lakes with cool, clear water.

Feeding Habits: Primarily insectivorous, feeding on midges, mayflies and caddisflies. Strain invertebrate from bottom material.

Spawning Habits: In Iowa, individuals have been reported to become sexually mature at three years of age. Spawning occurs in the spring when water temperatures reach 52°F in shallow water over sand or gravel substrates. As with white suckers, there is no deliberate nest construction. Females produce up to 30,000 eggs, which are scattered over the stream bottom and then abandoned.

Comments: Of the five individuals collected in June, 1974, at the Little Powder River Site No. 2, none were gravid. As all were less than five inches in length, these were

most probably juvenile fish. In 1975, one mature male in spawning colors was captured at Little Powder No. 1.

River Carpsucker (Carpiodes carpio). (From: Baxter and Simon, 1970; Scott and Crossman, 1973; Harlan and Speaker, 1951; Deacon, 1961; Buchholz, 1957.)

Adult Size: Up to 10 pounds in Wyoming.

Life Expectancy: Unknown.

Range: From Montana to Pennsylvania and south to Tennessee and Texas. In Wyoming, found in the Big Horn, Powder, Little Powder, Belle Fourche, and North Platte river basins.

Preferred Habitat: Quiet pools in clear and turbid streams, but not common in rubble-bottomed streams.

Feeding Habits: Primarily herbivorous, but also some small invertebrates.

Spawning Habits: Spawning occurs from April to June with the eggs being scattered over the stream bottom and left unattended.

Comments: During the June, 1974 sampling at Little Powder River Site No. 2 neither of the two individuals collected were gravid. Either spawning had previously occurred or these were juvenile forms (both were less than six inches in length). Neither of two 1975 fish collected were gravid.

Plains Killifish (Fundulus kansae). (From: Baxter and Simon, 1970; Scott and Crossman, 1973; Eddy and Underhill, 1974.)

Adult Size: Up to 4 inches.

Life Expectancy: Unknown.

Range: From Oklahoma to South Dakota, on the Great Plains. In Wyoming, primarily east of the Continental Divide. Present

in the southeast corner of the state in the North and South Platte River drainages. Also present in the Cheyenne River drainage, Ocean Lake, Owl Creek, and Big Horn River. Species is tolerant of water containing high values of total solids, primarily sulfates of magnesium and sodium.

Preferred Habitat: Warm water, sandy, shallow streams. Is tolerant to shifting sand bottoms, high salinities.

Feeding Habits: Feeds on surface, open water. Is primarily carnivorous, mostly small insects.

Spawning Habits: Spawning usually occurs in late summer, with water temperatures ranging near 82°F, over gravel in shallow water, 2-4 inches. Some Killifishes spawn throughout summer. Deposited eggs are buried, presumably from the shifting of sand.

Comments: An extremely hardy and aggressive species. Can be used as a bait fish, but not preferred. No gravid individuals found in June, 1975 sampling.

Plains Minnow (Hybognathus placitus). (From: Baxter and Simon, 1970; Scott and Crossman, 1973; Eddy and Underhill, 1974.)

Adult Size: Up to 6 inches, usually 4-5 inches.

Life Expectancy: Unknown.

Range: The Great Plains, mainly west of the Missouri River from North Dakota and Montana south to central Texas. In Wyoming, found in the Bighorn, Tongue, Powder, Little Powder, Little Missouri, Belle Fourche and Cheyenne rivers. Is native to the North Platte River.

Preferred Habitat: Turbid side pools of silty streams, in slower water. Common associates are the flathead chub and river carpsucker.

Feeding Habits: Mainly herbivorous, but does include aquatic invertebrates in the diet.

Spawning Habits: Unknown for this species. Presumably eggs are scattered in silt-bottomed backwaters, with the breeding season apparently extended.

Comments: Ripe females were collected on Antelope Creek in June, 1975.

Benthic Invertebrates.

Little Powder River. The benthic invertebrates collected during 1975 at the Little Powder sites were found to represent 5 phyla, 7 classes, 14 orders, 24 families and at least 27 genera. This compares with 3 phyla, 6 classes, 12 orders, 19 families and at least 26 genera identified in the 1974 samples. The taxonomic classification for the 1975 organisms is presented in Table 9, while Tables 10 and 11 summarize the bottom fauna data obtained at each site

Site No. 1. During the April and June sampling periods, oligocheates (aquatic worms) were the predominant organisms at Site No. 1 on a numbers basis, comprising 51.8 and 70.0 percent, respectively, of the totals collected. This parallels the 1974 findings when oligocheates were the most abundant type at each of the three sampling times (June, August and late October). Dubiraphia larvae (beetles) predominated in the October and January samples, contributing 54.8 and 33.0 percent of numbers. Considering biomass, Physa sp. (freshwater snails) were

TABLE 9

TAXONOMIC CLASSIFICATION OF BENTHIC FAUNA FROM THE LITTLE POWDER RIVER

Phylum	Class	Order	Family	Genus
Arthropoda	Insecta	Diptera (two-winged flies)	Chironomidae	Chironomus sp.
				Pentaneura sp.
			Ceratopogonidae	Palpomyia sp.
			Culicidae	Chaoborus sp.
			Tabanidae	Tabanus sp.
				Chrysops sp.

			Tipulidae	----
		Coleoptera (beetles)	Elmidae	Dubiraphia sp.
			Hydrophilidae	Berosus sp.
			Haliplidae	Brychius sp.
			Dytiscidae	Laccophilus sp.

		Ephemeroptera (mayfly)	Caenidae	Caenis sp.
		Odonata (damsel- and dragonflies)	Coenagrionidae	Ischnura sp.
				Type A
				Type B
				Enallagma sp.
				Type A
				Type B
			Gomphidae	Ophiogomphus sp.
			Libellulidae	Macromia sp.
		Hemiptera (water bugs)	Corixidae	----
		Trichoptera (caddisfly)	Psychomyiidae	Polycentropus sp
	Crustacea	Amphipoda (shrimp)	Talitridae	Hyallela azteca
Mollusca	Gastropoda	Pulmonata (snails)	Physidae	Physa sp.
			Lymnaeidae	Lymnaea sp.
	Pelecypoda	Sphaeriacea (clams)	Sphaeridae	Sphaerium sp.
Annelida	Clittellata	Hirudinea (leeches)	Glossiphoniidae	----
		Oligocheata (worms)	Tubificidae	----
Nematomorpha	Gordiordia (horse-hair worms)	----	----	----
Nematoda	Aphasmidia (round worm)	Enoplida	Mermithidae	----
	----	----	----	----

TABLE 10

SUMMARY OF BOTTOM FAUNA COLLECTED AT LITTLE POWDER RIVER SITE NO. 1

				April 1975				June 1975				October 1975				January 1976			
Class	Order	Family	Genus	No.	% Total No.	Biomass (mg.)	% Total Biomass	No.	% Total No.	Biomass (mg.)	% Total Biomass	No.	% Total No.	Biomass (mg.)	% Total Biomass	No.	% Total No.	Biomass (mg.)	% Total Biomass
Insecta	Diptera	Chironomidae	Chironomus sp.	8	5.6	3.9	5.4	0				0				2	0.5	0.9	2.0
			Pentaneura sp.	41	29.5	1.4	1.9	2	8.7	0.2	2.2	3	1.1	0.3	0.3	62	16.8	1.3	2.9
		Cerotopogonidae	Palpomyia sp.	0				0				0				71	19.2	0.7	1.6
		Culicidae	Chaoborus sp.	1	0.7	0.3	0.4	0				0				0			
		Tipulidae	----	0				0				0				1	0.3	0.1	0.2
	Ephemeroptera	Caenidae	Caenis sp.	0				1	4.3	0.1	1.1	38	14.6	2.2	2.4	52	14.1	2.1	4.7
	Hemiptera	Corixidae	----	1	0.7	0.4	0.6	0				1	0.4	1.0	1.1	0			
	Coleoptera	Elmidae	Dubiraphia sp. (larvae)	1	0.7	0.5	0.7	1	4.3	0.1	1.1	143	54.8	3.8	4.1	122	33.0	10.2	22.8
			Dubiraphia sp. (adults)	0				0				10	3.8	1.2	1.3	7	1.9	1.4	3.1
		Haplidae	Brychius sp. (larvae)	0				0				1	0.4	1.1	1.2	0			
		Hydrophilidae	Berosus sp. (larvae)	0				0				1	0.4	0.5	0.5	0			
		Dytiscidae	Laccophilus sp.	0				0				0				1	0.3	0.3	0.7
	Odonata	Coenagrionidae	Unidentifiable piece	0				0				1	0.4	0.2	0.2	0			
			Unidentifiable piece	0				0				1	0.4	3.1	3.3	0			
			Ischnura sp.	0				0				2	0.8	1.0	1.1	0			
			Enallagma sp.	0				0				1	0.4	0.6	0.6	4	1.1	1.1	2.4
Crustacea	Amphipoda	Talitridae	Hyallela azteca	1	0.7	0.1	0.1	0				14	5.4	0.9	1.0	3	0.8	0.2	0.4
Gastropoda	Pulmonata	Physidae	Physa sp.	6	4.3	31.1	42.7	1	4.3	4.7	52.8	17	6.5	56.6	60.6	9	2.4	22.0	49.2
		Lymnaeidae	Lymnaea sp.	4	2.9	13.0	17.9	0				2	0.8	0.9	1.0	0			
Pelecypoda	Sphaeriacea	Sphaeridae	Sphaerium sp.	1	0.7	10.4	14.3	0				2	0.8	17.0	18.2	0			

TABLE 10 (Continued)

Class	Order	Family	Genus	April 1975				June 1975				October 1975				January 1976			
				No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass
Gordiordia (horse-hair worms)	----	----	----	2	1.4	0.3	0.4	0				0				0			
Aphasmidia (round worm)	Enoplida	Mermithidae	----	1	0.7	0.6	0.8	0				0				0			
----	----	----	----	0				1	4.3	0.2	2.2	0				0			
Unidentifiable roundworm		(Phylum Nematoda)																	
Clittellata	Oligocheata	Tubificidae	----	72	51.8	10.7	14.7	16	70.0	3.4	38.2	24	9.2	3.0	3.2	36	9.7	4.4	9.8
		----	----	0				1	4.3	0.2	2.2	0				0			
Totals				139	(99.7)	72.7	(99.9)	23	(100.2)	8.9	(99.8)	261	(100.2)	93.4	(100.1)	370	(100.1)	44.7	(99.8)

TABLE 11

SUMMARY OF BOTTOM FAUNA COLLECTED AT LITTLE POWDER RIVER SITE NO. 2

				April 1975				June 1975				October 1975				January 1976			
Class	Order	Family	Genus	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass
Insecta	Diptera	Chironomidae	Pentaneura sp.	21	24.7	1.0	13.5	2	2.1	0.2	0.7	9	4.1	0.2	0.2	125	23.9	3.5	5.4
			Chironomus sp.	4	4.7	1.5	20.2	0				5	2.3	0.1	0.08	0			
		Ceratopogonidae	Palpomyia sp.	9	10.6	0.7	9.5	4	4.3	0.3	1.0	1	0.5	0.1	0.08	41	7.9	0.6	0.9
		Tabanidae	Unidentifiable piece	1	1.2	0.3	4.1	0				0				0			
			Tabanus sp.	0				0				0				3	0.6	0.3	0.5
			Chrysops sp.	0				0				0				1	0.2	8.3	12.9
		Tipulidae	----	1	1.2	0.2	2.7	0				0				0			
	Coleoptera	Elmidae	Dubiraphia sp. (larvae)	7	8.2	0.9	12.2	25	26.6	1.5	5.2	92	42.0	3.3	2.5	214	41.0	29.5	45.8
			Dubiraphia sp. (adults)	0				14	14.9	3.1	10.8	10	4.6	1.7	1.3	11	2.1	2.0	3.1
		Dystiscidae	----	0				1	1.1	0.9	3.1	0				0			
		Hydrophilidae	Berosus sp.	0				0				16	7.3	1.8	1.4	8	1.5	1.7	2.6
	Ephemeroptera	Caenidae	Caenis sp.	1	1.2	0.3	4.1	7	7.4	2.3	8.0	32	14.6	0.4	0.3	86	16.5	1.5	2.3
	Odonata	Coenagrionidae	Ischnura sp.	0				0				4	1.8	0.3	0.2	4	0.8	1.0	1.6
			Enallagma sp.	0				0				2	0.9	0.6	0.5	12	2.3	3.4	5.3
		Gomphidae	Ophiogomphus sp.	0				0				0				1	0.2	1.4	2.2
		Libellulidae	Macromia sp.	0				0				0				1	0.2	5.8	9.0
	Hemiptera	Corixidae	----	0				0				0				1	0.2	0.6	0.9
	Trichoptera	Psychomyiidae	Polycentropus sp.	0				0				0				1	0.2	0.2	.0.3
Clittellata	Oligocheata	Tubificidae	---- ----	40	47.1	2.2	29.8	39	41.5	13.8	48.3	26	11.9	1.0	0.8	9	1.7	0.9	1.4
	Hirudinea	Glossiphoniidae	----	1	1.2	0.3	4.1	0				0				0			
Gastropoda	Pulmonata	Physidae	Physa sp.	0				1	1.1	3.5	12.2	20	9.1	64.4	49.4	3	0.6	3.6	5.6
		Lymnaeidae	Lymnaea sp.	0				1	1.1	3.0	10.5	0				1	0.2	0.1	0.2
Pelecypoda	Sphaeriacea	Sphaeridae	Sphaerium sp.	0				0				2	0.9	56.5	43.3	0			
Totals				85	(100.1)	7.4	(100.2)	94	(100.1)	28.6	(99.8)	219	(100.0)	130.4	(100.1)	522	(100.1)	64.4	(100.0)

the most abundant on all sample dates, ranging from 42.7 percent of the total in April up to 60.6 percent in October. Other forms found to be quite common were diptera larvae, freshwater clams, and mayfly nymphs (g. Caenis). New taxa collected in 1975 included two genera of Diptera (Chaoborus and Tipulidae), three genera of beetles (Brychius, Berosus, Laccophilus), two types of damselflies (Ischnura and Enallagma), freshwater shrimp (Hyallela), clams (Sphaerium), and, horse-hair and round worms.

Site No. 2. The pattern of predominance at Site No. 2 in 1975 followed closely that at Site No. 1. In April and June, oligocheates had both highest number (47.1 and 41.5 percent respectively) and biomass (29.8 and 48.3 percent). Dubiraphia larvae predominated in the October and January samples, comprising over forty percent of the numbers collected. In October, freshwater snails (Physa sp.) totaled 49.4 percent of the total biomass. Other relatively common groups were diptera larvae, mayfly nymphs (g. Caenis), and freshwater clams (g. Sphaerium). New taxa collected in 1975 were two genera of beetles (Dytiscidae and Berosus), two dipterans (Tabanus and Tipulidae), one snail genus (Lymnaea), one caddisfly (Polycentropus), two damselflies (Ischnura and Enallagma), two dragonflies (Macromia and Ophigomphus), one water bug (Corixidae) and leeches (Glossiphoniidae).

Overall Trends and Community Structure. Tables 12 and 13 present the relative abundance of bottom fauna collected at the two study sites on both a numbers and a biomass per 0.1 square meter (m^2) basis, while Figure 6 compares these data with those obtained on the three 1974 sampling dates.

TABLE 12

RELATIVE ABUNDANCE OF BOTTOM FAUNA ON A NUMBERS BASIS
AT THE TWO LITTLE POWDER RIVER STUDY SITES

			Numbers of Organisms per $0.1m^2$							
			Site No. 1				Site No. 2			
Phylum	Class	Order	April	June	October	January	April	June	October	January
Arthropoda	Insecta	Diptera	35.8	1.4	2.2	97.5	25.8	4.3	10.7	121.9
		Ephemeroptera	0	0.7	27.2	37.3	0.7	5.0	22.9	61.6
		Hemiptera	0.7	0	0.7	0	0	0	0	0.7
		Coleoptera	0.7	0.7	111.1	93.2	5.0	28.7	84.6	167.0
		Odonata	0	0	3.6	2.9	0	0	4.3	12.9
		Trichoptera	0	0	0	0	0	0	0	0.7
	Crustacea	Amphipoda	0.7	0	10.0	2.2	0	0	0	0
Mollusca	Gastropoda	Pulmonata	7.2	0.7	13.7	6.5	0	1.4	14.3	2.9
	Pelecypoda	Sphaeriacea	0.7	0	1.4	0	0	0	1.4	0
Annelida	Clittellata	Hirudinea	0	0	0	0	0.7	0	0	0
		Oligocheata	52.0	12.2	17.2	25.8	31.5	28.0	18.6	6.5
Nematomorpha	Gordiordia	----	1.4	0	0	0	0	0	0	0
Nematoda	Aphasmidia	Enoplida	0.7	0	0	0	0	0	0	0
	Unidentifiable piece	----	0	0.7	0	0	0	0	0	0
Totals			99.9	16.4	187.1	265.4	63.7	67.4	156.8	374.2

TABLE 13

RELATIVE ABUNDANCE OF BOTTOM FAUNA ON A BIOMASS BASIS
AT THE TWO LITTLE POWDER RIVER SITES

			Milligrams (mg.) per 0.1 m^2							
			Site No. 1				Site No. 2			
Phylum	Class	Order	April	June	October	January	April	June	October	January
Arthropoda	Insecta	Diptera	4.0	0.1	0.2	2.2	2.7	0.4	0.3	9.1
		Ephemeroptera	0	0.1	1.6	1.5	0.2	1.6	0.3	1.1
		Hemiptera	0.3	0	0.7	0	0	0	0	0.4
		Coleoptera	0.4	0.1	4.7	8.5	0.6	3.9	4.9	23.8
		Odonata	0	0	3.5	0.8	0	0	0.7	8.3
		Trichoptera	0	0	0	0	0	0	0	0.1
	Crustacea	Amphipoda	0.1	0	0.6	0.1	0	0	0	0
Mollusca	Gastropoda	Pulmonata	31.6	3.4	41.2	15.8	0	4.7	46.2	2.7
	Pelecypoda	Sphaeriacea	7.5	0	12.2	0	0	0	40.5	0
Annelida	Clittellata	Hirudinea	0	0	0	0	0.2	0	0	0
		Oligocheata	7.7	2.6	2.2	3.2	1.6	9.9	0.7	0.7
Nematomorpha	Gordiordia	----	0.2	0	0	0	0	0	0	0
Nematoda	Aphasmidia	Enoplida	0.4	0	0	0	0	0	0	0
	----	----	0	0.1	0	0	0	0	0	0
Totals			52.2	6.4	66.9	32.1	5.3	20.5	93.6	46.2

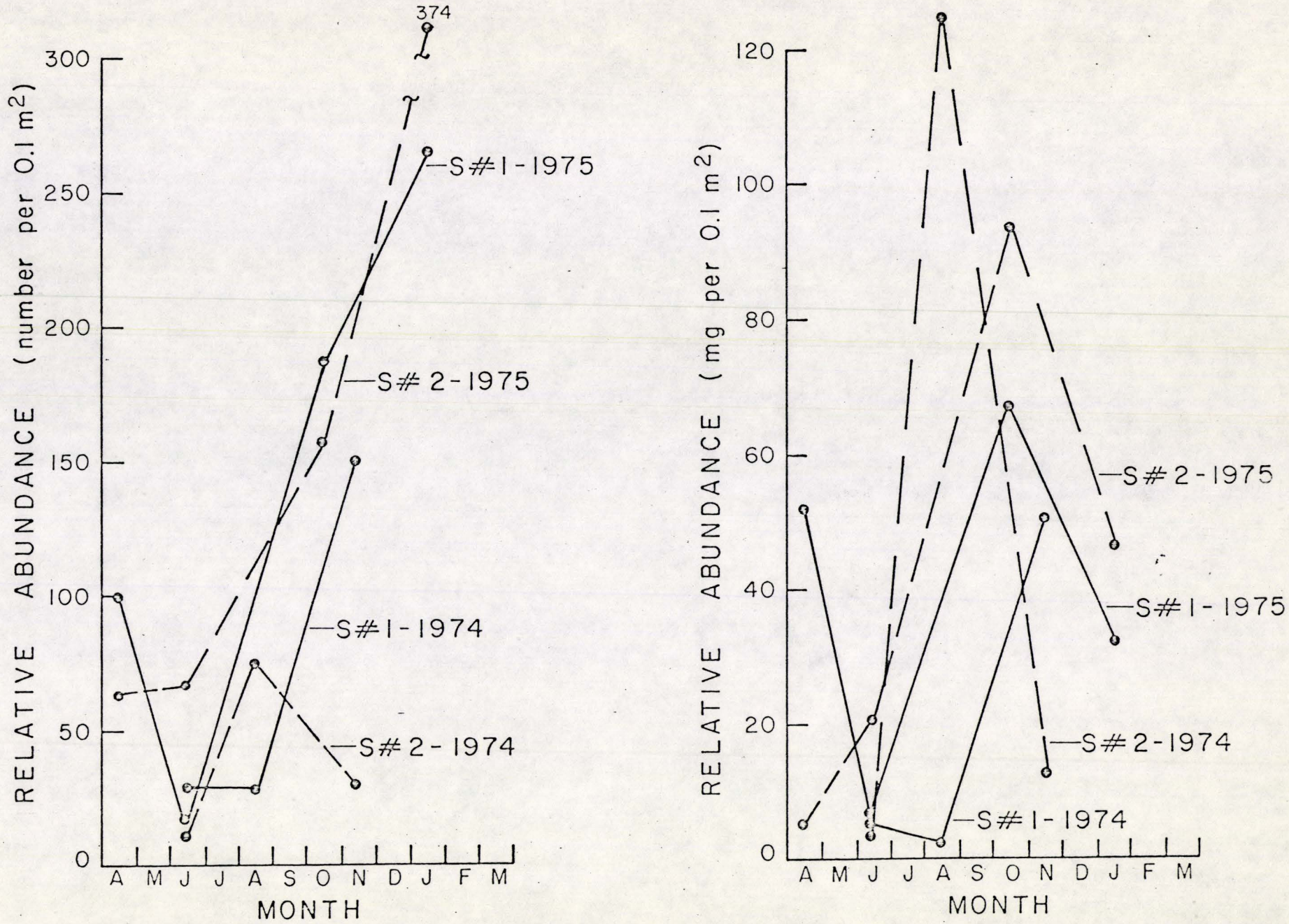

Figure 6. Relative Abundance of Bottom Fauna at the Little Powder River Study Sites in 1974 and 1975.

Inspection of the 1975 data indicates generally that relative abundance at the two sites is quite similar, as is also the case with seasonal trends. Overall, abundance appears to be decreasing in the spring and early summer, with increasing populations found in the fall and winter periods. A possible explanation for this would be that as water temperatures warm in the spring, predation increases and also adult insects begin breeding and then dying off. Hence, by late spring or early summer, many forms are present in the egg or very early juvenile stages and are not being picked up in the samples. By late summer or fall, these juveniles begin to appear. Also, as water temperatures decrease in the fall, the effects of predation are lessened. While the 1974 sampling did not include the winter and early spring seasons, a similar trend is indicated by the Site No. 1 data.

1975 relative abundance values generally ranged higher than 1974 levels. Natural fluctuation of population densities and increased growths of aquatic vegetation in 1975 probably explain this.

A summary of the relative abundance data for the Little Powder River bottom fauna collected in 1975 (grouping both sites together) is provided in Table 14. Considering all sample times together, the most abundant benthic types on a numbers basis were beetle larvae (39.8 percent), diptera larvae (24.3 percent), oligocheates (15.6 percent) and mayfly nymphs (12.6 percent). Comparisons with the 1974 data, where oligocheates (53.3 percent) ranked first, diptera larvae second (26.0 percent), and mayfly nymphs third (15.8 percent), are difficult due to the seasonal variation in sampling times between years. On a biomass basis, snails were the most abundant in 1975 (44.8 percent), followed by freshwater clams (18.6 percent) and beetle larvae (14.4 percent).

TABLE 14

SUMMARY OF RELATIVE ABUNDANCE DATA FOR THE BOTTOM FAUNA OF THE LITTLE POWDER RIVER

			April				June				October				January				Total			
Phylum	Class	Order	Mean No.	% Total	Mean Biomass (mg.)	% Total	Mean No.	% Total	Mean Biomass (mg.)	% Total	Mean No.	% Total	Mean Biomass (mg.)	% Total	Mean No.	% Total	Mean Biomass (mg.)	% Total	Mean No.	% Total	Mean Biomass (mg.)	% Total
Arthropoda	Insecta	Diptera	30.8	37.5	3.4	11.7	2.9	6.9	0.3	2.2	6.5	3.8	0.3	0.4	109.7	34.3	5.7	14.4	149.9	24.3	9.7	6.0
		Ephemeroptera	0.4	0.5	0.1	0.3	2.9	6.9	0.9	6.6	25.1	14.6	1.0	1.2	49.5	15.5	1.3	3.3	77.9	12.6	3.3	2.0
		Hemiptera	0.4	0.5	0.2	0.7	0	0	0	0	0.4	0.2	0.4	0.5	0.4	0.1	0.2	0.5	1.2	0.2	0.8	0.5
		Coleoptera	2.9	3.5	0.5	1.7	14.7	34.9	2.0	14.6	97.9	56.9	4.8	6.0	130.1	40.7	16.2	41.0	245.6	39.8	23.5	14.4
		Odonata	0	0	0	0	0	0	0	0	4.0	2.3	2.1	2.6	7.9	2.5	4.6	11.6	11.9	1.9	6.7	4.1
		Trichoptera	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0.1	0.1	0.3	0.4	0.1	0.1	0.1
	Crustacea	Amphipoda	0.4	0.5	0.1	0.3	0	0	0	0	5.0	2.9	0.3	0.4	1.1	0.3	0.1	0.3	6.5	1.1	0.5	0.3
Mollusca	Gastropoda	Pulmonata	3.6	4.4	15.8	54.5	1.1	2.6	4.1	29.9	14.0	8.1	43.7	54.3	4.7	1.5	9.3	23.5	23.4	3.8	72.9	44.8
	Pelecypoda	Sphaeriacea	0.4	0.5	3.8	13.1	0	0	0	0	1.4	0.8	26.4	32.8	0	0	0	0	1.8	0.3	30.2	18.6
Annelida	Clittellata	Hirudinea	0.4	0.5	0.1	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0.1	0.1	0.1
		Oligocheata	41.8	50.9	4.7	16.2	20.1	47.7	6.3	46.0	17.9	10.4	1.5	1.9	16.2	5.1	2.0	5.1	96.0	15.6	14.5	8.9
Nematomorpha	Gordiorda	----	0.7	0.9	0.1	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0.1	0.1	0.1
Nematoda	Aphasmidia	Enoplida	0.4	0.5	0.2	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0.1	0.2	0.1
	----	----	0	0	0	0	0.4	1.0	0.1	0.7	0	0	0	0	0	0	0	0	0.4	0.1	0.1	0.1
Totals			82.2	(100.2)	29.0	(99.8)	42.1	(100.0)	13.7	(100.0)	172.2	(100.0)	80.5	(100.1)	320.0	(100.1)	39.5	(100.0)	616.5	(100.1)	162.7	(100.1)

To provide a measure of the benthic community structure present, Shannon Diversity Index values were determined. Table 15 presents the 1975 values. Higher values indicate a higher community diversity, considering both the number of species present and the number of each species. To determine if statistically significant differences existed between study sites and sampling times, Kruskal-Wallis Rank-Sum tests were performed. The results of these tests are presented in Table 16. As shown, the only significant difference found at the .01 level was at Site No. 1 when testing between sampling dates. The seasonal trends discussed above would appear to be the cause for this.

Graphic comparisons between 1974 and 1975 Shannon Diversity Index values are provided in Figure 7. Overall, the trends of these data are similar to those for relative abundance. 1975 values generally ranged higher than those of 1974, while seasonally, diversity was highest in the fall and winter, lowest in the early summer.

TABLE 15

SHANNON SPECIES DIVERSITY INDEX VALUES
ON A NUMBERS AND BIOMASS BASIS FOR
BOTTOM FAUNA COLLECTED AT THE TWO
LITTLE POWDER RIVER STUDY SITES

	Index Values			
	Site No. 1		Site No. 2	
	Numbers	Biomass	Numbers	Biomass
April 1975	0.342	0.355	0.424	0.528
June 1975	0.204	0.192	0.302	0.263
October 1975	0.564	0.518	0.563	0.356
January 1976	0.599	0.566	0.643	0.603

TABLE 16

RESULTS OF KRUSKAL-WALLIS RANK-SUM TESTS
FOR SHANNON SPECIES DIVERSITY INDEX VALUES
AT LITTLE POWDER RIVER SITES

"Between Sampling Date" Values above 11.345 = Significant difference at .01 level

"Between Sampling Site) Values above 6.635 = Significant difference at .01 level

NUMBERS BASIS

Between Sampling Dates

Site No. 1	13.141
Site No. 2	6.466

Between Sampling Sites

April 24, 1975	1.987
June 23, 1975	2.021
October, 1975	1.560
January 14, 1976	2.227

BIOMASS BASIS

Between Sampling Dates

Site No. 1	10.336
Site No. 2	5.613

Between Sampling Sites

April 24, 1975	3.064
June 23, 1975	1.691
October, 1975	4.792
January 14, 1976	1.587

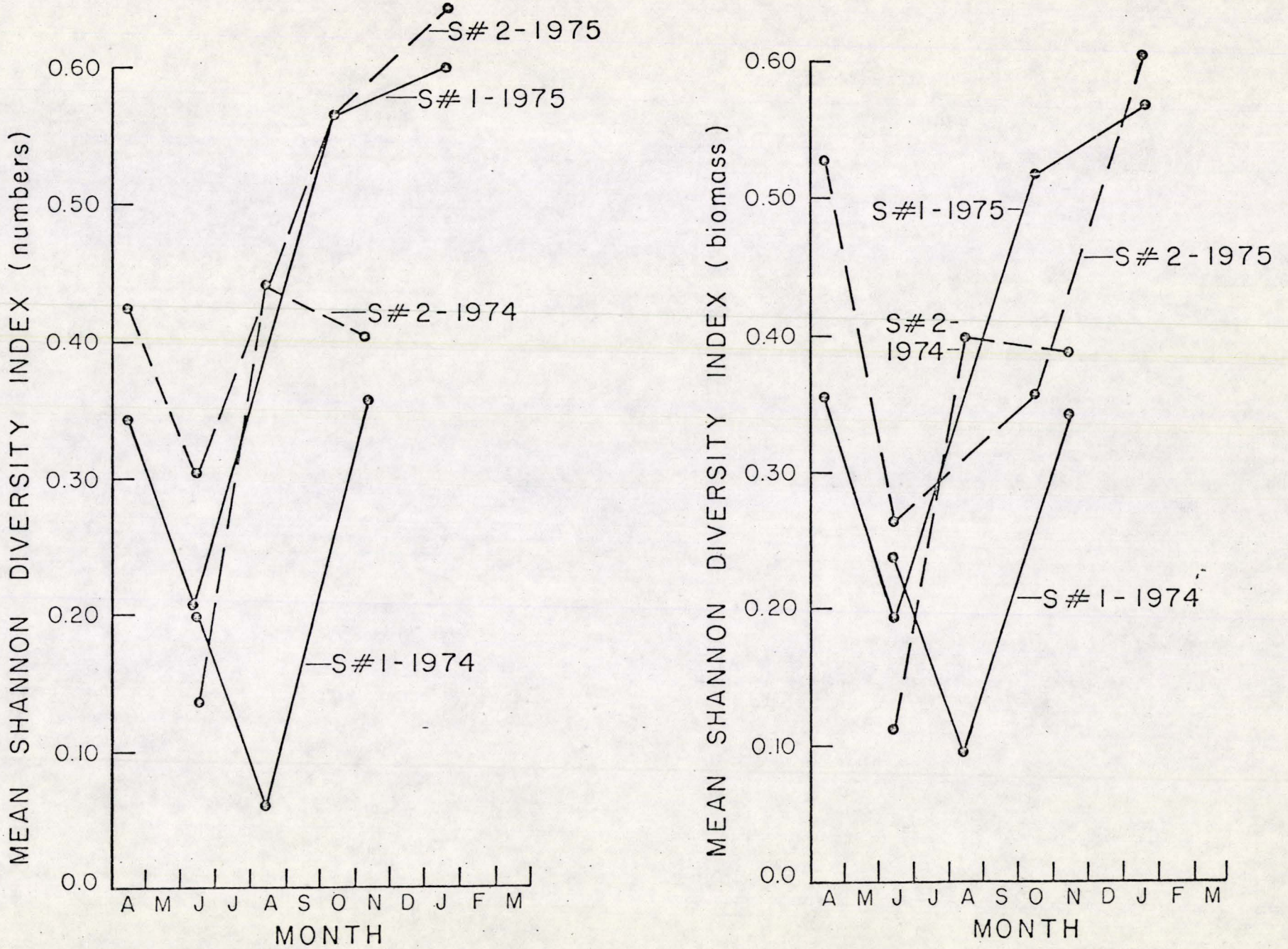

Figure 7. Mean Shannon Diversity Index Values at the Little Powder River Study Sites in 1974 and 1975.

Antelope Creek. The benthic invertebrates collected during 1975 at the three Antelope Creek study sites were found to represent 3 phyla, 6 classes, 13 orders, 22 families and at least 29 genera. The taxonomic classification of these organisms is presented in Table 17, while the bottom fauna collected at each site are summarized in Tables 18, 19, and 20.

Site No. 1. In the early May and late June samples, Diptera larvae (Pentaneura) predominated, comprising 77.8 and 70.0 percent of the total numbers collected. Two snail genera (Physa and Lymnaea) were the prevailing forms in the fall and winter samples, collectively accounting for 79.5 and 64.8 percent of the total numbers, and 75.3 and 77.4 percent of the biomass. Other invertebrate types which were quite common included oligochaetes, mayfly nymphs (Caenis) and freshwater clams (Sphaerium).

The numbers, biomass and speciation of organisms collected varied greatly throughout the year. In May, only 18 organisms representing 4 taxa and weighing 36.1 milligrams were found, while in the January samples, 3919 individuals of 22 types were counted, weighing 3569 milligrams.

Site No. 2. Diptera larvae, freshwater snails (Physa) and clams (Sphaerium) were the predominant members of the bottom fauna collected at Site No. 2 during 1975. The dipterans had high number in the May, June and January samples, collectively accounting for 66.7, 53.1 and 48.0 percent, respectively, of the totals. In October, freshwater clams (Sphaerium) totalled 60.0 percent of the numbers. Considering biomass, dipterans predominated in May (59.9 percent), snails (Physa) in June and January (49.2 and 95.7 percent) and, clams (54.0

TABLE 17

TAXONOMIC CLASSIFICATION OF BENTHIC FAUNA FROM ANTELOPE CREEK

Phylum	Class	Order	Family	Genus
Arthropoda	Insecta	Diptera (two-winged flies)	Chironomidae	*Pentaneura* sp.
				Chironomus sp.
			Ceratopogonidae	*Palpomyia* sp.
			Tabanidae	*Chrysops* sp.
				Tabanus sp.
			Dolichopodidae	----
			Stratiomyidae	----
			Liriopeidae	----
		Coleoptera (beetles)	Haliplidae	*Haliplus* sp.
				Peltodytes sp.
			Elmidae	*Dubiraphia* sp.
			Hydrophilidae	*Berosus* sp.
		Ephemeroptera (mayfly)	Caenidae	*Caenis* sp.
		Odonata (damsel- and dragonflies)	Coenagroinidae	*Enallagma* sp.
				Ischnura sp.
			Libellulidae	*Somatochlora* sp.
		Trichoptera (caddisfly)	Psychomyiidae	*Polycentropus* sp.
	Crustacea	Amphipoda (shrimp)	Talitridae	*Hyallela azteca*
		Cladocera (water fleas)	----	----
		Copepoda	----	----
	Arachnoidea	Hydracarina (water mites)	----	----
Annelida	Clittellata	Oligocheata (worms)	Tubificidae	Type A
				Type B
		Hirudinea (leeches)	Glossiphoniidae	Type A
				Type B

			Piscicolidae	----
Mollusca	Gastropoda	Pulmonata (snails)	Physidae	*Physa* sp.
			Lymnaeidae	*Lymnaea* sp.
	Pelecypoda	Sphaeriacea (clams)	Sphaeridae	*Sphaerium* sp.

TABLE 18

SUMMARY OF BOTTOM FAUNA COLLECTED AT ANTELOPE CREEK SITE NO. 1

				May 1975				June 1975				October 1975				January 1976			
Class	Order	Family	Genus	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass
Insecta	Diptera	Chironomidae	Pentaneura sp.	14	77.8	1.9	5.3	257	70.0	37.2	29.3	0				631	16.1	0.7	0.02
			Chironomus sp.	0				2	0.5	0.1	0.1	0				0			
		Ceratopogonidae	Palpomyia sp.	0				8	2.2	3.2	2.5	0				18	0.5	0.4	0.01
		Tabanidae	Chrysops sp.	1	5.6	2.9	8.0	0				3	0.2	0.3	0.01	0			
			Tabanus sp.	0				0				3	0.2	11.2	0.4	1	0.03	195.7	5.5
		Dolichopodidae	----	0				1	0.3	0.1	0.1	0				0			
	Ephemeroptera	Caenidae	Caenis sp.	0				55	15.0	26.3	20.7	0				183	4.7	1.8	0.05
	Coleoptera	Hydrophilidae	Berosus sp.	0				0				2	0.1	1.0	0.03	5	0.1	2.4	0.07
		Haliplidae	Peltodytes sp.	0				1	0.3	0.1	0.1	0				0			
			-- (larvae)	0				0				3	0.2	0.2	0.007	0			
			Haliplus sp.	0				0				0				27	0.7	18.2	0.5
	Odonata	Coenagrionidae	Enallagma sp.	0				1	0.3	0.2	0.2	0				1	0.03	0.1	0.003
			Ischnura sp.	0				6	1.6	6.0	4.7	0				3	0.08	2.8	0.08
			Unidentified piece	0				0				0				23	0.6	0.3	0.008
		Libellulidae	Somatochlora sp.	0				0				0				4	0.1	7.0	0.2
			Unidentified piece	0				0				0				2	0.05	0.8	0.02
	Trichoptera	Psychomyiidae	Polycentropus sp.	0				0				0				3	0.08	0.1	0.003
Crustacea	Amphipoda	Talitridae	Hyallela azteca	0				12	3.3	1.3	1.0	0				228	5.8	3.8	0.1
	Cladocera	----	----	0				1	0.3	0.1	0.1	0				0			
	Copepoda	----	----	0				1	0.3	0.1	0.1	0				0			
Arachnoidea	Hydrocarina	----	----	0				0				0				3	0.08	0.1	0.003

TABLE 18 (Continued)

Class	Order	Family	Genus	May 1975				June 1975				October 1975				January 1976			
				No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass
Clittellata	Oligocheata	Tubificidae	----	2	11.1	0.3	0.8	13	3.5	6.0	4.7	1	0.1	0.7	0.02	0			
	Hirudinea	Glossiphoniidae	----	0				0				8	0.5	3.0	0.10	2	0.05	2.4	0.07
			----													5	0.1	1.8	0.05
			----													4	0.1	1.3	0.04
		Piscicolidae	----	0				0				7	0.4	17.3	0.6	25	0.6	219.3	6.1
Gastropoda	Pulmonata	Physidae	Physa sp.	1	5.6	31.0	85.9	3	0.8	10.4	8.2	357	21.0	1141.5	38.5	741	18.9	2167.8	60.7
		Lymnaeidae	Lymnaea sp.	0				3	0.8	23.6	18.6	995	58.5	1090.1	36.8	1799	45.9	597.4	16.7
		Planorbidae	Gyraulus sp.	0				0				1	0.1	0.6	0.02	5	0.1	2.4	0.07
Pelecypoda	Sphaeriacea	Sphaeridae	Sphaerium sp.	0				3	0.8	12.3	10.0	320	18.8	699.3	23.6	206	5.3	342.4	9.6
Totals				18	(100.1)	36.1	(100.0)	367	(100.0)	127.0	(100.4)	1700	(100.1)	2965.2	(100.1)	3919	(100.3)	3569.0	(100.5)

TABLE 19

SUMMARY OF BOTTOM FAUNA COLLECTED AT ANTELOPE CREEK SITE NO. 2

Class	Order	Family	Genus	May 1975				June 1975				October 1975				January 1976			
				No.	% Total No.	Biomass (mg.)	% Total Biomass	No.	% Total No.	Biomass (mg.)	% Total Biomass	No.	% Total No.	Biomass (mg.)	% Total Biomass	No.	% Total No.	Biomass (mg.)	% Total Biomass
Insecta	Diptera	Chironomidae	Pentaneura sp. (larvae)	3	25.0	0.2	13.3	94	45.7	9.8	23.7	1	0.2	0.7	0.04	11	44.0	0.6	1.4
			(pupa)	0				1	0.5	0.1	0.2	0				0			
			Chironomus sp. (larvae)	0				3	1.5	0.4	1.0	2	0.4	0.2	0.01	0			
			(pupa)	0				2	1.0	0.7	1.7	0				0			
		Cerotopogonidae	Palpomyia sp.	2	16.7	0.2	13.3	1	0.5	0.1	0.2	0				1	4.0	0.1	0.2
		Dolichopodidae	----	3	25.0	0.5	33.3	6	2.9	0.5	1.2	0				0			
		Stratiomyidae	----	0				1	0.5	0.1	0.2	0				0			
		Liriopeidae (pupa)	----	0				1	0.5	0.1	0.2	0				0			
	Coleoptera	Haliplidae	Haliplus (larvae)	0				0				5	1.0	2.4	0.1	0			
		Elmidae	Dubiraphia (larvae)	1	8.3	0.3	20.0	0				1	0.2	0.1	0.01	1	4.0	0.1	0.2
		Hydrophilidae	Berosus (larvae)	0				0				1	0.2	0.1	0.01	0			
	Ephemeroptera	Caenidae	Caenis sp.	1	8.3	0.2	13.3	0				0				1	4.0	0.1	0.2
Crustacea	Amphipoda	Talitridae	Hyallela azteca	0				2	1.0	0.2	0.5	0				1	4.0	0.1	0.2
Clittellata	Oligocheata	Tubificidae	----	2	16.7	0.1	6.7	90	43.7	6.8	16.5	8	1.6	0.1	0.01	1	4.0	0.1	0.2
	Hirudinea	Glossiphoniidae	----	0				0				5	1.0	2.7	0.17	0			
		Piscicolidae	----	0				0				2	0.4	2.4	0.1	0			
Gastropoda	Pulmonata	Physidae	Physa sp.	0				4	1.9	20.3	49.2	156	31.5	788.3	43.3	8	32.0	40.1	95.7
		Lymnaeidae	Lymnaea sp.	0				0				17	3.4	40.3	2.2	1	4.0	0.7	1.7
Pelecypoda	Sphaeriacea	Sphaeridae	Sphaerium sp.	0				1	0.5	2.2	5.3	297	60.0	981.2	54.0	0			
Totals				12	(100.0)	1.5	(99.9)	206	(100.2)	41.3	(99.9)	495	(99.9)	1818.5	(99.95)	25	(100.0)	41.9	(99.8)

TABLE 20

SUMMARY OF BOTTOM FAUNA COLLECTED AT ANTELOPE CREEK SITE NO. 3

				May 1975				June 1975				October 1975				January 1976			
Class	Order	Family	Genus	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass	No.	% Total No.	Bio-mass (mg.)	% Total Bio-mass
Insecta	Diptera	Chironomidae	Pentaneura sp.	1	3.1	0.2	0.08	4	16.7	0.3	2.7	6	22.2	0.6	2.4	50	56.2	0.6	28.6
			Chironomus sp. (larvae)	18	56.2	10.9	4.2	0				3	11.1	0.3	1.2	0			
			(pupae)	2	6.3	0.7	0.3	0				0				0			
		Ceratopogonidae	Palpomyia sp.	1	3.1	0.2	0.08	3	12.5	0.5	4.5	1	3.7	0.1	0.4	34	38.2	0.5	23.8
	Coleoptera	Elmidae	Dubiraphia (larvae)	0				1	4.2	0.1	0.9	1	3.7	0.1	0.4	0			
Clittellata	Oligocheata	Tubificidae	----	4	12.5	0.5	0.2	15	62.5	2.3	20.5	4	14.8	0.4	1.6	3	3.3	0.3	14.4
Gastropoda	Pulmonata	Physidae	Physa sp.	6	18.8	245.7	95.2	1	4.2	8.0	71.4	8	29.6	20.8	83.5	1	1.1	0.2	9.5
		Lymnaeidae	Lymnaea sp.	0				0				3	11.1	2.1	8.4	1	1.1	0.5	23.8
Pelecypoda	Sphaeriacea	Sphaeridae	Sphaerium sp.	0				0				1	3.7	0.5	2.0	0			
Totals				32	(100.0)	258.2	(100.06)	24	(100.1)	11.2	(100.0)	27	(99.9)	24.9	(99.9)	89	(99.9)	2.1	(100.1)

percent) in October. The only other invertebrate type common throughout the year was the oligochaetes.

Site No. 2 was found to go completely dry at times throughout the year. This of course accounts for the relatively low numbers collected there (only 12 in May up to 206 in June). The October data (total of 495 organisms) had to be collected at a site several hundred feet below No. 2, as it was dry at that time. The appearance of at least some invertebrates in the January sample gives an indication of the ability of these forms to survive total dewatering by burrowing down into the substrate to find groundwater or to tolerate such conditions in the egg stage of their life history. Recruitment into Site No. 2 from upstream is also a possibility.

Site No. 3. Dipteran larvae, freshwater snails and oligocheates were the predominant members of the bottom fauna collected at Site No. 3. In May, October and January, Diptera had high number, representing 68.7, 37.0 and 94.4 percent, respectively, of the totals. Oligocheates comprised 62.5 percent of the June sample. Considering biomass, snails (Physa) accounted for 95.2, 71.4 and 83.5 percent in May, June and October, while in January, dipterans predominated with 52.4 percent of the total.

The numbers of invertebrates collected at Site No. 3 were relatively low throughout the year and showed little of the fluctuation found at No. 1. Low number (24) was in June, with the highest densities in January (89). Biomass, however, was lowest in January (2.1 milligrams) and ranged up to 258.2 milligrams in May.

Overall Trends and Community Structure. Tables 21 and 22

present the relative abundance of bottom fauna collected at the three study sites on both a numbers and a biomass per 0.1 m^2 basis, while mean Shannon Diversity Index values appear in Table 23. The results of the Kruskal-Wallis Rank-Sum tests are provided in Table 24. Table 25 contains a summary of the relative abundance data (grouping all three sites together) by sample dates.

Overall, the densest concentrations of bottom fauna were collected at Site No. 1, where relative abundance ranged from 12.9 organisms per 0.1 m^2 in May up to 2809.4 in January. No. 1 typically had the highest abundance on a biomass basis also. This was as expected due to the heavy growths of aquatic vegetation encountered here, and, while periods of zero flow were noted, the site remained wetted at all sample times. Diversity index values normally ranged higher at this site also.

In regard to seasonal variations, the general trend followed that of the Little Powder River sites. Relative abundance was lowest in the spring with increasing densities noted in the fall and winter samples.

Due in part at least to the more intermittent nature of Antelope Creek (when compared with the Little Powder River) statistically significant differences in community structure between both sampling sites and times were more commonplace. As this study is attempting to define baseline conditions and as only limited mineral development is underway in the basin, little comment can be made regarding these fluctuations, except that they are a natural phenomena of these populations.

Considering all sampling sites and times together, the most abundant invertebrate types collected in Antelope Creek were freshwater

TABLE 21

RELATIVE ABUNDANCE OF BOTTOM FAUNA ON A NUMBERS BASIS
AT THE THREE ANTELOPE CREEK STUDY SITES

			Numbers of Organisms per 0.1 m^2											
			Site No. 1				Site No. 2				Site No. 3			
Phylum	Class	Order	May	June	October	January	May	June	October	January	May	June	October	January
Arthropoda	Insecta	Diptera	10.8	192.1	4.3	465.9	5.7	78.1	2.2	8.6	15.8	5.0	7.2	60.2
		Ephemeroptera	0	39.4	0	131.2	0.7	0	0	0.7	0	0	0	0
		Coleoptera	0	0.7	3.6	22.9	0.7	0	5.0	0.7	0	0.7	0.7	0
		Odonata	0	5.0	0	23.7	0	0	0	0	0	0	0	0
		Trichoptera	0	0	0	2.2	0	0	0	0	0	0	0	0
	Crustacea	Amphipoda	0	8.6	0	163.4	0	1.4	0	0.7	0	0	0	0
		Cladocera	0	0.7	0	0	0	0	0	0	0	0	0	0
		Copepoda	0	0.7	0	0	0	0	0	0	0	0	0	0
	Arachnoidea	Hydracarina	0	0	0	2.2	0	0	0	0	0	0	0	0
Annelida	Clittellata	Oligocheata	1.4	9.3	0.7	0	1.4	64.5	5.7	0.7	2.9	10.8	2.9	2.2
		Hirudinea	0	0	10.8	25.8	0	0	5.0	0	0	0	0	0
Mollusca	Gastropoda	Pulmonata	0.7	4.3	969.9	1824.4	0	2.9	124.0	6.5	4.3	0.7	7.9	1.4
	Pelecypoda	Sphaeriacea	0	2.2	229.4	147.7	0	0.7	212.9	0	0	0	0.7	0
Totals			12.9	263.0	1218.7	2809.4	8.5	147.6	354.8	17.9	23.0	17.2	19.4	63.8

TABLE 22

RELATIVE ABUNDANCE OF BOTTOM FAUNA ON A BIOMASS BASIS
AT THE THREE ANTELOPE CREEK STUDY SITES

			Milligrams (mg.) per 0.1 m^2											
			Site No. 1				Site No. 2				Site No. 3			
Phylum	Class	Order	April	June	October	January	April	June	October	January	April	June	October	January
Arthropoda	Insecta	Diptera	3.4	29.1	8.2	141.1	0.6	8.5	0.6	0.5	8.6	0.6	0.7	0.8
		Ephemeroptera	0	18.9	0	1.3	0.1	0	0	0.1	0	0	0	0
		Coleoptera	0	0.1	0.9	14.8	0.2	0	1.9	0.1	0	0.1	0.1	0
		Odonata	0	4.4	0	7.9	0	0	0	0	0	0	0	0
		Trichoptera	0	0	0	0.1	0	0	0	0	0	0	0	0
	Crustacea	Amphipoda	0	0.9	0	2.7	0	0.1	0	0.1	0	0	0	0
		Cladocera	0	0.1	0	0	0	0	0	0	0	0	0	0
		Copepoda	0	0.1	0	0	0	0	0	0	0	0	0	0
	Arachnoidea	Hydracarina	0	0	0	0.1	0	0	0	0	0	0	0	0
Annelida	Clittellata	Oligocheata	0.2	4.3	0.5	0	0.1	4.9	0.1	0.1	0.4	1.6	0.3	0.2
		Hirudinea	0	0	14.6	161.1	0	0	3.7	0	0	0	0	0
Mollusca	Gastropoda	Pulmonata	22.2	24.3	1600.1	1983.9	0	14.6	594.0	29.2	176.1	5.7	16.4	0.5
	Pelecypoda	Sphaeriacea	0	8.8	501.3	245.4	0	1.6	703.4	0	0	0	0.4	0
Totals			25.8	91.0	2125.6	2558.4	1.0	29.7	1303.7	30.1	185.1	8.0	17.9	1.5

TABLE 23

SHANNON SPECIES DIVERSITY INDEX VALUES
ON A NUMBERS AND BIOMASS BASIS FOR
BOTTOM FAUNA COLLECTED AT THREE
ANTELOPE CREEK STUDY SITES

	Index Values					
	Site No. 1		Site No. 2		Site No. 3	
	Numbers	Biomass	Numbers	Biomass	Numbers	Biomass
May 1975	0.128	0.038	0.223	0.200	0.166	0.023
June 1975	0.461	0.385	0.444	0.360	0.133	0.124
October 1975	0.435	0.437	0.395	0.276	0.274	0.182
January 1976	0.618	0.469	0.293	0.141	0.342	0.341

TABLE 24

RESULTS OF KRUSKAL-WALLIS RANK-SUM TESTS
FOR SHANNON DIVERSITY INDEX VALUES
AT ANTELOPE CREEK SITES

"Between Sampling Dates" Values above 11.345 = Significant difference at .01 level

"Between Sampling Sites" Values above 9.210 = Significant difference at .01 level

NUMBER BASIS

Between Sampling Dates

Site No. 1	13.006
Site No. 2	3.641
Site No. 3	2.843

Between Sampling Sites

May, 1975	9.745
June, 1975	16.174
October, 1975	9.644
January, 1976	14.828

BIOMASS BASIS

Between Sampling Dates

Site No. 1	12.259
Site No. 2	4.392
Site No. 3	5.385

Between Sampling Sites

May, 1975	10.795
June, 1975	14.525
October, 1975	19.053
January, 1976	18.946

TABLE 25

SUMMARY OF RELATIVE ABUNDANCE DATA FOR THE BOTTOM FAUNA OF ANTELOPE CREEK

			April				June				October				January				Total			
Phylum	Class	Order	Mean No.	% Total	Mean Biomass (mg.)	% Total	Mean No.	% Total	Mean Biomass (mg.)	% Total	Mean No.	% Total	Mean Biomass (mg.)	% Total	Mean No.	% Total	Mean Biomass (mg.)	% Total	Mean No.	% Total	Mean Biomass (mg.)	% Total
Arthropoda	Insecta	Diptera	10.8	73.0	4.2	5.9	91.7	64.4	12.7	29.6	4.6	0.9	3.2	0.3	178.2	18.5	47.5	5.5	285.3	17.3	67.6	3.2
		Ephemeroptera	0.2	1.4	0.03	0.04	13.1	9.2	6.3	14.7	0	0	0	0	44.0	4.6	0.5	0.06	57.3	3.5	6.8	0.3
		Coleoptera	0.2	1.4	0.07	0.1	0.5	0.4	0.07	0.2	3.1	0.6	1.0	0.09	7.9	0.8	5.0	0.6	11.7	0.7	6.1	0.3
		Odonata	0	0	0	0	1.7	1.2	1.5	3.5	0	0	0	0	7.9	0.8	2.6	0.3	9.6	0.6	4.1	0.2
		Trichoptera	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0.07	0.03	0.003	0.7	0.04	0.03	0.001
	Crustacea	Amphipoda	0	0	0	0	3.3	2.3	0.3	0.7	0	0	0	0	54.7	5.7	0.9	0.1	58.0	3.5	1.2	0.06
		Cladocera	0	0	0	0	0.2	0.1	0.03	0.07	0	0	0	0	0	0	0	0	0.2	0.01	0.03	0.001
		Copepoda	0	0	0	0	0.2	0.1	0.03	0.07	0	0	0	0	0	0	0	0	0.2	0.01	0.03	0.001
	Arachnoidea	Hydracarina	0	0	0	0	0	0	0	0	0	0	0	0	0.7	0.07	0.03	0.003	0.7	0.04	0.03	0.001
Annelida	Clittellata	Oligocheata	1.9	12.8	0.2	0.3	28.2	19.8	3.6	8.4	3.1	0.6	0.3	0.03	1.0	0.1	0.1	0.01	34.2	2.1	4.2	0.2
		Hirudinea	0	0	0	0	0	0	0	0	5.3	1.0	6.1	0.5	8.6	0.9	53.7	6.2	13.9	0.8	59.8	2.8
Mollusca	Gastropoda	Pulmonata	1.7	11.5	66.1	93.6	2.6	1.8	14.9	34.7	367.3	69.2	736.8	64.1	610.8	63.4	671.2	77.7	982.4	59.5	1489.0	70.0
	Pelecypoda	Sphaeriacea	0	0	0	0	1.0	0.7	3.5	8.2	147.7	27.8	401.7	35.0	49.2	5.1	81.8	9.5	197.9	12.0	487.0	22.9
Totals			14.8	(100.1)	70.6	(99.9)	142.5	(100.0)	42.9	(100.1)	531.1	(100.1)	1149.1	(100.0)	963.7	(100.0)	863.4	(100.0)	1652.1	(100.1)	2125.9	(100.0)

snails (predominantly Physa). They comprised 59.5 percent of the total number collected and 70.0 percent of the biomass. Other quite common forms were Diptera larvae and freshwater clams.

Water Quality

Water quality results are reported on WRRI laboratory sheets for each of the three Antelope Creek sample sites and for the two Little Powder River sample sites for each of the four sample dates as listed below.

Little Powder River

Site 1	4-24-75	pages 73 and 74
Site 2	4-24-75	pages 75 and 76
Site 1	6-23-75	pages 77 and 78
Site 2	6-23-75	pages 79 and 80
Site 1	10-8-75	pages 81 and 82
Site 2	10-8-75	pages 83 and 84
Site 1	1-13-75	pages 85 and 86
Site 2	1-13-75	pages 87 and 88

Antelope Creek

Site 1	5-8-75	pages 89 and 90
Site 2	5-8-75	pages 91 and 92
Site 3	5-8-75	pages 93 and 94
Site 1	6-23-75	pages 95 and 96
Site 2	6-23-75	pages 97 and 98
Site 3	6-23-75	pages 99 and 100
Site 1	10-8-75	pages 101 and 102
Site 2	10-8-75	pages 103 and 104
Site 3	10-8-75	pages 105 and 106
Site 1	1-13-76	pages 107 and 108
Site 2	1-13-76	pages 109 and 110
Site 3	1-13-76	pages 111 and 112

These data are summarized in Tables 26 and 27 while Tables 28 and 29 present the maximum, minimum and expected range of each constituent. The expected range should be viewed as an estimate rather than an absolute. Much can occur to cause values to fall outside the projected range. Additional data can assist in redefining this range.

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 4-24-75 Facility Name _____

Stream Name(s)
Little Powder River

Source of Sample: (Exact Location)
Site #1 - South Site, upstream

Physical Observations, Remarks: | Weather Cond. _____

Temp. (air) _____ °F
Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
8.9 cfs	8.8 mg/1	8.3	10° C.

CATIONS	meq/1	mg/1	(Base Average)	ANIONS	meq/1	mg/1	(Base Average)
Calcium (Ca)	4.24	85	66.7	Carbonate (CO_3)	0.00	0.0	0.0
Magnesium (Mg)	3.64	44	74.3	Bicarbonate (HCO_3)	3.35	204	310.3
Sodium (Na)	6.48	149	311	Sulfate (SO_4)	11.34	545	865.7
Potassium (K)	0.26	10	8.7	Chloride (Cl)	0.17	6.2	9.7
				Nitrate (NO_3)	0.02	1.0	1.4
				*Phosphate (PO_4) as (P)		0.05	0.03
				Fluoride (F)	0.00	0.1	0.4
Total Cations	14.62			Total Anions	14.88		

Values reported are mg/1 unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
1319	(1859.3)	Conductance(μMHOS)	0.0	(6.0)	Ammonia (N)
46	(38.3)	COD	3.0	(17.0)	Total Kjeldahl (N)
7.6	( )	pH	0.05	(0.03)	Phosphate (PO_4)
85	(582.7)	Turbidity (JTU)	627	(8647.7)	Susp. Solids
394	(472.0)	Hardness	52	( )	Vol. Susp. Solids
168	(152.3)	Alkalinity	942	(1524.7)	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

1605 Total (10172.3)

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 4-24-75

Stream Name(s): Little Powder River

Source of Sample: Site #1 - South

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.01	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		1.4	( )	Manganese
	0.0	(0.14)	Boron		<0.001	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		0.001	(0.002)	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		0.05	(0.14)	Zinc
	0.1	(0.3)	Fluoride		<0.008	( )	Cyanide
	1.3	(3.9)	Iron (Total)		<0.01	( )	MBAS
	3.2	( )	Iron (Dissolved)		0.003	( )	Phenol (ppm)
			BOD		2.1	(1.5)	Oil & Grease
			Fecal Coliforms 100 ml			( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 4-24-75 Facility Name _____

Stream Name(s)
Little Powder River

Source of Sample: (Exact Location)
Site #2 - North Site, downstream

Physical Observations, Remarks: | Weather Cond. _____

Temp. (air) _____ °F
Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
16.2 cfs	9.0 mg/1	7.9	14° C.

CATIONS	meq/1	mg/1	(Base Average)	ANIONS	meq/1	mg/1	(Base Average)
Calcium (Ca)	2.44	49	64	Carbonate (CO_3)	0.00	0.0	0
Magnesium (Mg)	2.17	26	61	Bicarbonate (HCO_3)	2.00	122	331.3
Sodium (Na)	4.13	95	290.3	Sulfate (SO_4)	6.49	312	768.7
Potassium (K)	0.21	8.4	8	Chloride (Cl)	0.26	9.1	9.7
				Nitrate (NO_3)	0.02	0.9	1.5
				*Phosphate (PO_4) as (P)		0.04	0.02
				Fluoride (F)	0.00	0.0	0.6
Total Cations	8.95			Total Anions	8.77		

Values reported are mg/1 unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
812	(1691.3)	Conductance (μMHOS)	0.0	(2.7)	Ammonia (N)
	( )	COD	5.9	(13.3)	Total Kjeldahl (N)
7.4	( )	pH	0.04	(0.02)	Phosphate (PO_4)
23	(535.7)	Turbidity (JTU)	1151	(11880)	Susp. Solids
231	(412)	Hardness	108	( )	Vol. Susp. Solids
100	(162.7)	Alkalinity	562	(1384)	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

1715 Total (13264)

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 4-24-75

Stream Name(s): Little Powder River

Source of Sample: Site #2 - North

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		1.6	( )	Manganese
	0.0	(0.14)	Boron		<0.001	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		0.002	(0.001)	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		0.02	(0.19)	Zinc
	0.0	(0.6)	Fluoride		<0.008	( )	Cyanide
	1.6	(9.9)	Iron (Total)		<0.01	( )	MBAS
	0.3	( )	Iron (Dissolved)		0.001	(0.011)	Phenol (ppm)
			BOD			( )	Oil & Grease
			Fecal Coliforms 100 ml			( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 6-23-75 Facility Name _____

Stream Name(s)
Little Powder River

Source of Sample: (Exact Location)
Site #1 - South Site, upstream

Physical Observations, Remarks: | Weather Cond. _____

Temp. (air) _____ °F
Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
6.17 cfs	6.2 mg/l	8.3	18° C.

CATIONS	meq/l	mg/l	(Base Average)	ANIONS	meq/l	mg/l	(Base Average)
Calcium (Ca)	3.09	62	66.7	Carbonate (CO_3)	0.00	0.0	0.0
Magnesium (Mg)	8.41	100	74.3	Bicarbonate (HCO_3)	4.10	250	310.3
Sodium (Na)	7.96	180	311	Sulfate (SO_4)	13.43	650	865.7
Potassium (K)	0.26	10	8.7	Chloride (Cl)	1.90	67	9.7
				Nitrate (NO_3)	0.02	1.1	1.4
				*Phosphate (PO_4) as (P)		0.04	0.03
				Fluoride (F)	0.02	0.4	0.4
Total Cations	19.72			Total Anions	19.47		

Values reported are mg/l unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
1500	(1859.3)	Conductance (μMHOS)	0.0	(6.0)	Ammonia (N)
41	(38.3)	COD	1.0	(17.0)	Total Kjeldahl (N)
7.6	( )	pH	0.04	(0.03)	Phosphate (PO_4)
	( )	Turbidity (JTU)	380	(8647.7)	Susp. Solids
580	(472.0)	Hardness	138	( )	Vol. Susp. Solids
210	(152.3)	Alkalinity	1203	(1524.7)	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

1260 Total (10,172.3)

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 6-23-75

Stream Name(s): Little Powder River

Source of Sample: Site #1 - South

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.0	( )	Manganese
	0.5	(0.14)	Boron		<0.001	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		0.001	(0.002)	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		0.02	(0.14)	Zinc
	0.4	(0.3)	Fluoride		<0.008	( )	Cyanide
	5.5	(3.9)	Iron (Total)		<0.01	( )	MBAS
	0.0	( )	Iron (Dissolved)		<0.001	( )	Phenol (ppm)
			BOD		1.9	(1.5)	Oil & Grease
			Fecal Coliforms 100 ml			( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 6-23-75 Facility Name _____

Stream Name(s)
Little Powder River

Source of Sample: (Exact Location)
Site #2 - North Site, downstream

Physical Observations, Remarks:	Weather Cond. _____
	Temp. (air) _____ °F
	Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
7.65 cfs	7.2 mg/l	8.0	24.5° C.

CATIONS	meq/l	mg/l	(Base Average)	ANIONS	meq/l	mg/l	(Base Average)
Calcium (Ca)	3.61	72	64	Carbonate (CO_3)	0.00	0.0	0
Magnesium (Mg)	6.90	84	61	Bicarbonate (HCO_3)	4.10	250	331.3
Sodium (Na)	8.55	200	290.3	Sulfate (SO_4)	13.61	650	768.7
Potassium (K)	0.25	9.8	8	Chloride (Cl)	1.23	44	9.7
				Nitrate (NO_3)	0.02	1.1	1.5
				*Phosphate (PO_4) as (P)		0.04	0.02
				Fluoride (F)	0.02	0.4	0.6
Total Cations	19.31			Total Anions	18.98		

Values reported are mg/l unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
1500	(1691.3)	Conductance (μMHOS)	0.0	(2.7)	Ammonia (N)
36	(32.7)	COD	1.8	(13.3)	Total Kjeldahl (N)
7.7	( )	pH	0.04	(0.02)	Phosphate (PO_4)
	( )	Turbidity (JTU)	444	(11880)	Susp. Solids — 1280 Total (13264)
530	(412)	Hardness	26	( )	Vol. Susp. Solids
210	(162.7)	Alkalinity	1194	(1384)	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 6-23-75

Stream Name(s): Little Powder River

Source of Sample: Site #2 - North

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.1	( )	Manganese
	0.2	(0.14)	Boron		<0.001	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		0.001	(0.001)	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		0.03	(0.19)	Zinc
	0.4	(0.6)	Fluoride		<0.008	( )	Cyanide
	1.3	(9.9)	Iron (Total)		<0.01	( )	MBAS
	0.0	( )	Iron (Dissolved)		0.002	(0.011)	Phenol (ppm)
			BOD		0.4	(2.1)	Oil & Grease
			Fecal Coliforms 100 ml			( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 10-8-75 Facility Name _____

Stream Name(s)
Little Powder River

Source of Sample: (Exact Location)
Site #1 - South Site, upstream

Physical Observations, Remarks:	Weather Cond. _____
	Temp. (air) _____ °F
	Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
0 cfs	5.6 mg/1	8.0	8.9° C.

CATIONS	meq/1	mg/1	(Base Average)	ANIONS	meq/1	mg/1	(Base Average)
Calcium (Ca)	6.49	130	66.7	Carbonate (CO_3)	0.00	0.0	0.0
Magnesium (Mg)	8.72	106	74.3	Bicarbonate (HCO_3)	6.80	415	310.3
Sodium (Na)	24.05	553	311	Sulfate (SO_4)	29.73	1430	865.7
Potassium (K)	0.48	19	8.7	Chloride (Cl)	0.31	11	9.7
				Nitrate (NO_3)	0.01	1.0	1.4
				*Phosphate (PO_4) as (P)		0.03	0.03
				Fluoride (F)	0.05	1.0	0.4
Total Cations	39.74			Total Anions	36.90		

Values reported are mg/1 unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
3236	(1859.3)	Conductance(μMHOS)	0.0	(6.0)	Ammonia (N)
38	(38.3)	COD	1.1	(17.0)	Total Kjeldahl (N)
8.1	( )	pH	0.03	(0.03)	Phosphate (PO_4)
9.0	(582.7)	Turbidity (JTU)	24	(8647.7)	Susp. Solids
761	(472.0)	Hardness	8.0	( )	Vol. Susp. Solids
317	(152.3)	Alkalinity	2830	(1524.7)	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

2850 Total (10,172.3)

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 10-8-75

Stream Name(s): Little Powder River

Source of Sample: Site #1 - South

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.06	( )	Manganese
	0.7	(0.14)	Boron		<0.001	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		0.001	(0.002)	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		0.13	(0.14)	Zinc
	1.0	(0.3)	Fluoride		<0.008	( )	Cyanide
	0.8	(3.9)	Iron (Total)		0.01	( )	MBAS
	0.2	( )	Iron (Dissolved)		0.03	( )	Phenol (ppm)
			BOD		0.1	(1.5)	Oil & Grease
			Fecal Coliforms 100 ml		0.0	( )	Sulfides

SPECIAL INSTRUCTIONS

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Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 10-8-75 Facility Name _____

Stream Name(s)
Little Powder River

Source of Sample: (Exact Location)
Site #2 - North Site, downstream

Physical Observations, Remarks: | Weather Cond. _____

Temp. (air) _____ °F
Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
0 cfs	9.3 mg/l	8.0	13.3° C.

CATIONS	meq/l	mg/l	(Base Average)	ANIONS	meq/l	mg/l	(Base Average)
Calcium (Ca)	6.54	131	64	Carbonate (CO_3)	0.00	0.0	0
Magnesium (Mg)	9.58	117	61	Bicarbonate (HCO_3)	7.42	453	331.3
Sodium (Na)	32.76	753	290.3	Sulfate (SO_4)	39.70	1910	768.7
Potassium (K)	0.43	17	8	Chloride (Cl)	0.51	18	9.7
				Nitrate (NO_3)	0.01	0.6	1.5
				*Phosphate (PO_4) as (P)		0.05	0.02
				Fluoride (F)	0.06	1.2	0.6
Total Cations	49.31			Total Anions	47.70		

Values reported are mg/l unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
4313	(1691.3)	Conductance(μMHOS)	0.0	(2.7)	Ammonia (N)
30	(32.7)	COD	1.0	(13.3)	Total Kjeldahl (N)
8.3	( )	pH	0.05	(0.02)	Phosphate (PO_4)
19	(535.7)	Turbidity (JTU)	48	(11880)	Susp. Solids
807	(412)	Hardness	10	( )	Vol. Susp. Solids
320	(162.7)	Alkalinity	3540	(1384)	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

3590 Total (13264)

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 10-8-75

Stream Name(s): Little Powder River

Source of Sample: Site #2 - North

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.32	( )	Manganese
	0.6	(0.14)	Boron		<0.001	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		0.002	(0.001)	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		0.03	(0.19)	Zinc
	1.2	(0.6)	Fluoride		<0.008	( )	Cyanide
	0.7	(9.9)	Iron (Total)		<0.01	( )	MBAS
	0.2	( )	Iron (Dissolved)		<0.001	(0.011)	Phenol (ppm)
			BOD		1.0	(2.1)	Oil & Grease
			Fecal Coliforms 100 ml		0.0	(0.2)	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 1-13-76 Facility Name _____

Stream Name(s)
Little Powder River

Source of Sample: (Exact Location)
Site #1 - South Site, upstream

Physical Observations, Remarks:	Weather Cond. _____
	Temp. (air) _____ °F
	Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
~0 cfs	7.04 mg/1	7.6-8.0	0° C.

CATIONS	meq/1	mg/1	(Base Average)	ANIONS	meq/1	mg/1	(Base Average)
Calcium (Ca)	7.36	150	66.7	Carbonate (CO_3)	0.00	0.0	0.0
Magnesium (Mg)	8.02	98	74.3	Bicarbonate (HCO_3)	13.40	820	310.3
Sodium (Na)	32.22	740	311	Sulfate (SO_4)	36.29	1700	865.7
Potassium (K)	0.26	10	8.7	Chloride (Cl)	0.44	16	9.7
				Nitrate (NO_3)	0.00	0.2	1.4
				*Phosphate (PO_4) as (P)		0.03	0.03
				Fluoride (F)	0.07	1.3	0.4
Total Cations	47.86			Total Anions	50.20		

Values reported are mg/1 unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
3880	(1859.3)	Conductance(μMHOS)	0.0	(6.0)	Ammonia (N)
26	(38.3)	COD	0.9	(17.0)	Total Kjeldahl (N)
8.1	( )	pH	0.03	(0.03)	Phosphate (PO_4)
32	(582.7)	Turbidity (JTU)	21	(8647.7)	Susp. Solids
770	(472.0)	Hardness	9.9	( )	Vol. Susp. Solids
641	(152.3)	Alkalinity	3220	(1524.7)	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

3240 Total (10172.3)

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 1-13-76

Stream Name(s): Little Powder River

Source of Sample: Site #1 - South

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/1 unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.04	( )	Manganese
	0.19	(0.14)	Boron		<0.002	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		<0.001	(0.002)	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		0.02	(0.14)	Zinc
	1.3	(0.3)	Fluoride		<0.02	( )	Cyanide
	0.24	(3.9)	Iron (Total)		<0.01	( )	MBAS
	0.0	( )	Iron (Dissolved)		<0.001	( )	Phenol (ppm)
			BOD		0.0	(1.5)	Oil & Grease
			Fecal Coliforms 100 ml		0.0	( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 1-13-76 Facility Name _____

Stream Name(s)
Little Powder River

Source of Sample: (Exact Location)
Site #2 - North Site, downstream

Physical Observations, Remarks:	Weather Cond.
	Temp. (air) ____ °F
	Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
<1 cfs	6.84 mg/1	7.9	0° C.

CATIONS	meq/1	mg/1	(Base Average)	ANIONS	meq/1	mg/1	(Base Average)
Calcium (Ca)	7.36	150	64	Carbonate (CO_3)	0.00	0.0	0
Magnesium (Mg)	7.81	95	61	Bicarbonate (HCO_3)	13.00	790	331.3
Sodium (Na)	31.68	730	290.3	Sulfate (SO_4)	35.20	1700	768.7
Potassium (K)	0.29	11	8	Chloride (Cl)	0.35	12	9.7
				Nitrate (NO_3)	0.00	0.2	1.5
				*Phosphate (PO_4) as (P)		0.03	0.02
				Fluoride (F)	0.06	1.2	0.6
Total Cations	47.14			Total Anions	48.61		

Values reported are mg/1 unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
3750	(1691.3)	Conductance (μMHOS)	0.0	(2.7)	Ammonia (N)
23	(32.7)	COD	0.7	(13.3)	Total Kjeldahl (N)
8.1	( )	pH	0.03	(0.02)	Phosphate (PO_4)
22	(535.7)	Turbidity (JTU)	20	(11880)	Susp. Solids — 3110 Total (13264)
760	(412)	Hardness	8.2	( )	Vol. Susp. Solids
621	(162.7)	Alkalinity	3090	(1384)	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 1-13-76

Stream Name(s): Little Powder River

Source of Sample: Site #2 - North

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/1 unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.14	( )	Manganese
	0.17	(0.14)	Boron		<0.002	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		<0.001	(0.001)	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		0.02	(0.19)	Zinc
	1.2	(0.6)	Fluoride		<0.02	( )	Cyanide
	0.28	(9.9)	Iron (Total)		<0.01	( )	MBAS
	0.0	( )	Iron (Dissolved)		0.007	(0.011)	Phenol (ppm)
			BOD		0.3	(2.1)	Oil & Grease
			Fecal Coliforms 100 ml		0.0	(0.2)	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 5-8-75 Facility Name _____

Stream Name(s)

Antelope Creek

Source of Sample: (Exact Location)

Site #1 - below Antelope Mine on Antelope Creek

Physical Observations, Remarks:	Weather Cond. _____
	Temp. (air) _____ °F
	Ground Cond. _____

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
14.1 cfs	9.6 mg/l	8.2	10.0° C.

CATIONS	meq/l	mg/l	(Base Average)	ANIONS	meq/l	mg/l	(Base Average)
Calcium (Ca)	5.76	116		Carbonate (CO_3)	0.00	0.0	
Magnesium (Mg)	3.41	42		Bicarbonate (HCO_3)	4.55	278	
Sodium (Na)	5.44	125		Sulfate (SO_4)	10.11	486	
Potassium (K)	0.18	7.0		Chloride (Cl)	0.69	24	
				Nitrate (NO_3)	0.00	0.0	
				*Phosphate (PO_4) as (P)		0.01	
				Fluoride (F)	0.00	0.0	
Total Cations	14.79			Total Anions	15.35		

Values reported are mg/l unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
1270	( )	Conductance(μMHOS)	0.0	( )	Ammonia (N)
16	( )	COD	0.6	( )	Total Kjeldahl (N)
8.1	( )	pH	0.01	( )	Phosphate (PO_4)
20	( )	Turbidity (JTU)	2.5	( )	Susp. Solids
459	( )	Hardness	0.0	( )	Vol. Susp. Solids
228	( )	Alkalinity	938	( )	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

947 Total

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 5-8-75

Stream Name(s): Antelope Creek

Source of Sample: Site #1 - below Antelope Mine

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	0.01	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.2	( )	Manganese
	0.0	( )	Boron		<0.001	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		<0.001	( )	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		<0.02	( )	Zinc
	0.0	( )	Fluoride		<0.008	( )	Cyanide
	0.6	( )	Iron (Total)		<0.01	( )	MBAS
	0.1	( )	Iron (Dissolved)		<0.001	( )	Phenol (ppm)
			BOD		1.1	( )	Oil & Grease
			Fecal Coliforms 100 ml			( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 5-8-75 Facility Name _____

Stream Name(s)
Antelope Creek

Source of Sample: (Exact Location)
Site #2 - above Irwin Ranch on Antelope Creek

Physical Observations, Remarks: | Weather Cond. _____

Temp. (air) _____ °F
Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
10.6 cfs	8.7 mg/l	8.6	16.0° C.

CATIONS	meq/l	mg/l	(Base Average)	ANIONS	meq/l	mg/l	(Base Average)
Calcium (Ca)	6.31	126		Carbonate (CO_3)	0.00	0.0	
Magnesium (Mg)	3.69	45		Bicarbonate (HCO_3)	3.85	235	
Sodium (Na)	5.96	137		Sulfate (SO_4)	11.51	553	
Potassium (K)	0.21	8.1		Chloride (Cl)	1.34	47	
				Nitrate (NO_3)	0.00	0.3	
				*Phosphate (PO_4) as (P)		0.01	
				Fluoride (F)	0.01	0.3	
Total Cations	16.17			Total Anions	16.71		

Values reported are mg/l unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
1407	( )	Conductance(μMHOS)	0.0	( )	Ammonia (N)
14	( )	COD	1.5	( )	Total Kjeldahl (N)
7.3	( )	pH	0.01	( )	Phosphate (PO_4)
25	( )	Turbidity (JTU)	1.6	( )	Susp. Solids
500	( )	Hardness	0.0	( )	Vol. Susp. Solids
193	( )	Alkalinity	1033	( )	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

1048 Total

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 5-8-75

Stream Name(s): Antelope Creek

Source of Sample: Site #2 - above Irwin Ranch

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	0.02	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.2	( )	Manganese
	0.0	( )	Boron		0.007	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		<0.001	( )	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		<0.02	( )	Zinc
	0.3	( )	Fluoride		<0.008	( )	Cyanide
	1.0	( )	Iron (Total)		<0.01	( )	MBAS
	0.1	( )	Iron (Dissolved)		<0.001	( )	Phenol (ppm)
			BOD		0.1	( )	Oil & Grease
			Fecal Coliforms 100 ml			( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 5-8-75 Facility Name _____

Stream Name(s)
Antelope Creek

Source of Sample: (Exact Location)
Site #3 - above Fiddle Back Ranch on Antelope Creek

Physical Observations, Remarks:	Weather Cond. _____
	Temp. (air) _____ °F
	Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
9.9 cfs	11.4 mg/1	8.6	10.5° C.

CATIONS	meq/1	mg/1	(Base Average)	ANIONS	meq/1	mg/1	(Base Average)
Calcium (Ca)	7.20	144		Carbonate (CO_3)	0.00	0.0	
Magnesium (Mg)	4.63	56		Bicarbonate (HCO_3)	4.00	244	
Sodium (Na)	7.66	176		Sulfate (SO_4)	15.71	755	
Potassium (K)	0.26	10		Chloride (Cl)	0.62	22	
				Nitrate (NO_3)	0.00	0.3	
				*Phosphate (PO_4) as (P)		0.01	
				Fluoride (F)	0.03	0.5	
Total Cations	19.75			Total Anions	20.36		

Values reported are mg/1 unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
1707	( )	Conductance (μMHOS)	0.0	( )	Ammonia (N)
24	( )	COD	1.2	( )	Total Kjeldahl (N)
8.1	( )	pH	0.01	( )	Phosphate (PO_4)
42	( )	Turbidity (JTU)	3.3	( )	Susp. Solids
592	( )	Hardness	0.0	( )	Vol. Susp. Solids
200	( )	Alkalinity	1285	( )	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

1353 Total

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 5-8-75

Stream Name(s): Antelope Creek

Source of Sample: Site #3 - above Fiddle Back Ranch

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.2	( )	Manganese
	0.0	( )	Boron		<0.001	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		<0.001	( )	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		<0.02	( )	Zinc
	0.5	( )	Fluoride		<0.008	( )	Cyanide
	1.3	( )	Iron (Total)		<0.01	( )	MBAS
	0.1	( )	Iron (Dissolved)		<0.001	( )	Phenol (ppm)
			BOD		1.1	( )	Oil & Grease
			Fecal Coliforms 100 ml			( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 6-23-75 Facility Name _____

Stream Name(s)
Antelope Creek

Source of Sample: (Exact Location)
Site #1 - below Antelope Mine on Antelope Creek

Physical Observations, Remarks: | Weather Cond. _____

Temp. (air) _____ °F
Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
3.08 cfs	8.0 mg/l	8.2	19.0° C.

CATIONS	meq/l	mg/l	(Base Average)	ANIONS	meq/l	mg/l	(Base Average)
Calcium (Ca)	6.78	136		Carbonate (CO_3)	0.00	0.0	
Magnesium (Mg)	4.23	51		Bicarbonate (HCO_3)	3.45	211	
Sodium (Na)	7.37	170		Sulfate (SO_4)	15.10	730	
Potassium (K)	0.21	8.1		Chloride (Cl)	0.57	20	
				Nitrate (NO_3)	0.00	0.2	
				*Phosphate (PO_4) as (P)		0.03	
				Fluoride (F)	0.03	0.6	
Total Cations	18.59			Total Anions	19.15		

Values reported are mg/l unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
1600	( )	Conductance (μMHOS)	0.0	( )	Ammonia (N)
47	( )	COD	0.7	( )	Total Kjeldahl (N)
7.9	( )	pH	0.03	( )	Phosphate (PO_4)
	( )	Turbidity (JTU)	32	( )	Susp. Solids — 1210 Total
550	( )	Hardness	4.0	( )	Vol. Susp. Solids
170	( )	Alkalinity	1220	( )	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 6-23-75

Stream Name(s): Antelope Creek

Source of Sample: Site #1 - below Antelope Mine

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.1	( )	Manganese
	0.1	( )	Boron		0.002	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		<0.001	( )	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		<0.02	( )	Zinc
	0.6	( )	Fluoride		<0.008	( )	Cyanide
	0.9	( )	Iron (Total)		0.02	( )	MBAS
	0.0	( )	Iron (Dissolved)		0.007	( )	Phenol (ppm)
			BOD		0.8	( )	Oil & Grease
			Fecal Coliforms 100 ml			( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 6-23-75 Facility Name _____

Stream Name(s)
Antelope Creek

Source of Sample: (Exact Location)
Site #2 - above Irwin Ranch on Antelope Creek

Physical Observations, Remarks: | Weather Cond. _____

Temp. (air) _____ °F
Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
4.0 cfs	6.4 mg/1	7.9	30.0° C.

CATIONS	meq/1	mg/1	(Base Average)	ANIONS	meq/1	mg/1	(Base Average)
Calcium (Ca)	7.21	140		Carbonate (CO_3)	0.00	0.0	
Magnesium (Mg)	8.59	100		Bicarbonate (HCO_3)	4.57	280	
Sodium (Na)	7.67	180		Sulfate (SO_4)	17.94	860	
Potassium (K)	0.27	11		Chloride (Cl)	1.59	56	
				Nitrate (NO_3)	0.00	0.2	
				*Phosphate (PO_4) as (P)		0.02	
				Fluoride (F)	0.03	0.7	
Total Cations	23.74			Total Anions	24.13		

Values reported are mg/1 unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
1800	( )	Conductance (μMHOS)	0.0	( )	Ammonia (N)
20	( )	COD	0.7	( )	Total Kjeldahl (N)
8.0	( )	pH	0.02	( )	Phosphate (PO_4)
	( )	Turbidity (JTU)	192	( )	Susp. Solids — 1580 Total
790	( )	Hardness	46	( )	Vol. Susp. Solids
230	( )	Alkalinity	1502	( )	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 6-23-75

Stream Name(s): Antelope Creek

Source of Sample: Site #2 - above Irwin Ranch

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.0	( )	Manganese
	0.2	( )	Boron		0.002	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		<0.001	( )	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		<0.02	( )	Zinc
	0.7	( )	Fluoride		<0.008	( )	Cyanide
	0.7	( )	Iron (Total)		<0.01	( )	MBAS
	0.0	( )	Iron (Dissolved)		0.002	( )	Phenol (ppm)
			BOD		1.5	( )	Oil & Grease
			Fecal Coliforms 100 ml			( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 6-23-75 Facility Name _____

Stream Name(s)
Antelope Creek

Source of Sample: (Exact Location)
Site #3 - above Fiddle Back Ranch on Antelope Creek

Physical Observations, Remarks: | Weather Cond. _____

Temp. (air) _____ °F
Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
6.54 cfs	7.6 mg/l	8.3	29.0° C.

CATIONS	meq/1	mg/1	(Base Average)	ANIONS	meq/1	mg/1	(Base Average)
Calcium (Ca)	8.88	178		Carbonate (CO_3)	0.00	0.0	
Magnesium (Mg)	5.63	68		Bicarbonate (HCO_3)	4.40	268	
Sodium (Na)	7.67	176		Sulfate (SO_4)	18.44	890	
Potassium (K)	0.30	12		Chloride (Cl)	0.57	20	
				Nitrate (NO_3)	0.01	0.8	
				*Phosphate (PO_4) as (P)		0.02	
				Fluoride (F)	0.03	0.7	
Total Cations	22.48			Total Anions	23.45		

Values reported are mg/1 unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
1900	( )	Conductance (μMHOS)	0.0	( )	Ammonia (N)
52	( )	COD	1.1	( )	Total Kjeldahl (N)
8.1	( )	pH	0.02	( )	Phosphate (PO_4)
	( )	Turbidity (JTU)	480	( )	Susp. Solids — 1700 Total
730	( )	Hardness	104	( )	Vol. Susp. Solids
220	( )	Alkalinity	1476	( )	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 6-23-75

Stream Name(s): Antelope Creek

Source of Sample: Site #3 - above Fiddle Back Creek

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/1 unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.0	( )	Manganese
	0.3	( )	Boron		<0.001	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		0.001	( )	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		<0.02	( )	Zinc
	0.7	( )	Fluoride		<0.008	( )	Cyanide
	0.4	( )	Iron (Total)		<0.01	( )	MBAS
	0.1	( )	Iron (Dissolved)		<0.001	( )	Phenol (ppm)
			BOD		1.6	( )	Oil & Grease
			Fecal Coliforms 100 ml			( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 10-8-75 Facility Name _____

Stream Name(s)
Antelope Creek

Source of Sample: (Exact Location)
Site #1 - below Antelope Mine on Antelope Creek

Physical Observations, Remarks: | Weather Cond. _____

Temp. (air) _____ °F
Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
0 cfs	17.4 mg/1	8.0-8.5	18.3° C.

CATIONS	meq/1	mg/1	(Base Average)	ANIONS	meq/1	mg/1	(Base Average)
Calcium (Ca)	2.94	59		Carbonate (CO_3)	0.00	0.0	
Magnesium (Mg)	3.02	37		Bicarbonate (HCO_3)	5.65	345	
Sodium (Na)	8.58	197		Sulfate (SO_4)	9.87	474	
Potassium (K)	0.20	7.9		Chloride (Cl)	0.44	16	
				Nitrate (NO_3)	0.00	0.2	
				*Phosphate(PO_4)as(P)		0.01	
				Fluoride (F)	0.06	1.1	
Total Cations	14.74			Total Anions	16.02		

Values reported are mg/1 unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
1496	( )	Conductance(μMHOS)	0.0	( )	Ammonia (N)
28	( )	COD	0.7	( )	Total Kjeldahl (N)
8.3	( )	pH	0.01	( )	Phosphate (PO_4)
2.5	( )	Turbidity (JTU)	22	( )	Susp. Solids
298	( )	Hardness	10	( )	Vol. Susp. Solids
241	( )	Alkalinity	964	( )	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

990 Total

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____
Date sample rec'd: _____ Time: _____
Date analysis completed: _____
Date results forwarded: _____
Total tests requested: _____ Tests run: _____
Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 10-8-75

Stream Name(s): Antelope Creek

Source of Sample: Site #1 - below Antelope Mine

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.00	( )	Manganese
	0.2	( )	Boron		<0.001	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		0.001	( )	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		<0.02	( )	Zinc
	1.1	( )	Fluoride		<0.008	( )	Cyanide
	0.8	( )	Iron (Total)		<0.01	( )	MBAS
	0.3	( )	Iron (Dissolved)		0.001	( )	Phenol (ppm)
			BOD		0.9	( )	Oil & Grease
			Fecal Coliforms 100 ml		0.0	( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 10-8-75 Facility Name _____

Stream Name(s)
Antelope Creek

Source of Sample: (Exact Location)
Site #2 - above Irwin Ranch on Antelope Creek

Physical Observations, Remarks: | Weather Cond. _____

Temp. (air) _____ °F
Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
0 cfs	4.88 mg/1	8.0	7.8° C.

CATIONS	meq/1	mg/1	(Base Average)	ANIONS	meq/1	mg/1	(Base Average)
Calcium (Ca)	9.79	196		Carbonate (CO_3)	0.00	0.0	
Magnesium (Mg)	6.05	74		Bicarbonate (HCO_3)	7.48	456	
Sodium (Na)	7.51	173		Sulfate (SO_4)	17.20	826	
Potassium (K)	0.37	14		Chloride (Cl)	0.58	21	
				Nitrate (NO_3)	0.00	0.2	
				*Phosphate (PO_4) as (P)		0.04	
				Fluoride (F)	0.05	0.9	
Total Cations				Total Anions			

Values reported are mg/1 unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
2041	( )	Conductance (μMHOS)	0.0	( )	Ammonia (N)
22	( )	COD	0.5	( )	Total Kjeldahl (N)
7.8	( )	pH	0.04	( )	Phosphate (PO_4)
54	( )	Turbidity (JTU)	126	( )	Susp. Solids
793	( )	Hardness	18	( )	Vol. Susp. Solids
373	( )	Alkalinity	1640	( )	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

1770 Total

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 10-8-75

Stream Name(s): Antelope Creek

Source of Sample: Site #2 - above Irwin Ranch

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.97	( )	Manganese
	0.4	( )	Boron		<0.001	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		0.001	( )	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		0.03	( )	Zinc
	0.9	( )	Fluoride		<0.008	( )	Cyanide
	2.1	( )	Iron (Total)		<0.01	( )	MBAS
	0.1	( )	Iron (Dissolved)		0.08	( )	Phenol (ppm)
			BOD		0.7	( )	Oil & Grease
			Fecal Coliforms 100 ml		0.0	( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 10-8-75 Facility Name _____

Stream Name(s)
Antelope Creek

Source of Sample: (Exact Location)
Site #3 - above Fiddle Back Ranch on Antelope Creek

Physical Observations, Remarks:	Weather Cond. _____
	Temp. (air) _____ °F
	Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
<1 cfs	10.4 mg/1	8.0	6.1° C.

CATIONS	meq/1	mg/1	(Base Average)	ANIONS	meq/1	mg/1	(Base Average)
Calcium (Ca)	13.12	263		Carbonate (CO_3)	0.00	0.0	
Magnesium (Mg)	10.04	122		Bicarbonate (HCO_3)	5.45	333	
Sodium (Na)	12.78	294		Sulfate (SO_4)	28.79	1380	
Potassium (K)	0.46	18		Chloride (Cl)	0.85	30	
				Nitrate (NO_3)	0.00	0.2	
				*Phosphate (PO_4) as (P)			
				Fluoride (F)	0.05	1.0	
Total Cations	36.40			Total Anions	35.14		

Values reported are mg/1 unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
2966	( )	Conductance(μMHOS)	0.0	( )	Ammonia (N)
13	( )	COD	0.5	( )	Total Kjeldahl (N)
8.0	( )	pH	0.03	( )	Phosphate (PO_4)
2.6	( )	Turbidity (JTU)	74	( )	Susp. Solids
1159	( )	Hardness	14	( )	Vol. Susp. Solids
271	( )	Alkalinity	2610	( )	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

2680 Total

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 10-8-75

Stream Name(s): Antelope Creek

Source of Sample: Site #3 - above Fiddle Back Ranch

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.13	( )	Manganese
	0.1	( )	Boron		<0.001	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		0.001	( )	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		0.02	( )	Zinc
	1.0	( )	Fluoride		<0.008	( )	Cyanide
	0.7	( )	Iron (Total)		<0.01	( )	MBAS
	0.1	( )	Iron (Dissolved)		0.009	( )	Phenol (ppm)
			BOD		0.5	( )	Oil & Grease
			Fecal Coliforms 100 ml		0.0	( )	Sulfides

SPECIAL INSTRUCTIONS

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University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 1-13-76 Facility Name _____

Stream Name(s) Antelope Creek

Source of Sample: (Exact Location)
Site #1 - below Antelope Mine on Antelope Creek

Physical Observations, Remarks: | Weather Cond. _____

Temp. (air) _____ °F
Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
0 cfs	2.28 mg/1	7.6	0° C.

CATIONS	meq/1	mg/1	(Base Average)	ANIONS	meq/1	mg/1	(Base Average)
Calcium (Ca)	8.73	180		Carbonate (CO_3)	0.00	0.0	
Magnesium (Mg)	5.55	68		Bicarbonate (HCO_3)	5.80	350	
Sodium (Na)	9.27	210		Sulfate (SO_4)	18.37	880	
Potassium (K)	0.19	7.4		Chloride (Cl)	0.69	24	
				Nitrate (NO_3)	0.00	0.0	
				*Phosphate(PO_4)as(P)		0.02	
				Fluoride (F)	0.05	1.0	
Total Cations	23.74			Total Anions	24.91		

Values reported are mg/1 unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
2010	( )	Conductance(μMHOS)	0.0	( )	Ammonia (N)
16	( )	COD	0.5	( )	Total Kjeldahl (N)
7.8	( )	pH	0.02	( )	Phosphate (PO_4)
	( )	Turbidity (JTU)	9.9	( )	Susp. Solids
710	( )	Hardness	8.2	( )	Vol. Susp. Solids
251	( )	Alkalinity	1600	( )	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

1610 Total

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____
Date sample rec'd: _____ Time: _____
Date analysis completed: _____
Date results forwarded: _____
Total tests requested: _____ Tests run: _____
Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 1-13-76

Stream Name(s): Antelope Creek

Source of Sample: Site #1 - below Antelope Mine

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		1.9	( )	Manganese
	0.14	( )	Boron		<0.002	( )	Mercury
	<0.01	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		<0.001	( )	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		0.09	( )	Zinc
	1.0	( )	Fluoride		<0.02	( )	Cyanide
	1.0	( )	Iron (Total)		<0.01	( )	MBAS
	0.0	( )	Iron (Dissolved)		<0.001	( )	Phenol (ppm)
			BOD		0.0	( )	Oil & Grease
			Fecal Coliforms 100 ml		0.0	( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 1-13-76 Facility Name _____

Stream Name(s)

Antelope Creek

Source of Sample: (Exact Location)

Site #2 - above Irwin Ranch on Antelope Creek

Physical Observations, Remarks: | Weather Cond. _____

Temp. (air) _____ °F

Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
0 cfs		7.8	0° C.

CATIONS	meq/l	mg/l	(Base Average)	ANIONS	meq/l	mg/l	(Base Average)
Calcium (Ca)	12.10	240		Carbonate (CO_3)	0.00	0.0	
Magnesium (Mg)	7.81	95		Bicarbonate (HCO_3)	6.30	380	
Sodium (Na)	8.22	190		Sulfate (SO_4)	21.76	1000	
Potassium (K)	0.34	13		Chloride (Cl)	0.49	17	
				Nitrate (NO_3)	0.00	0.0	
				*Phosphate (PO_4) as (P)		0.02	
				Fluoride (F)	0.05	1.0	
Total Cations	28.47			Total Anions	28.60		

Values reported are mg/l unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average		
2290	( )	Conductance(μMHOS)	0.0	( )	Ammonia (N)	
26	( )	COD	0.7	( )	Total Kjeldahl (N)	
8.1	( )	pH	0.02	( )	Phosphate (PO_4)	
6.5	( )	Turbidity (JTU)	13	( )	Susp. Solids	1970 Total
1000	( )	Hardness	12	( )	Vol. Susp. Solids	
332	( )	Alkalinity	1960	( )	TDS	
	( )	Total Acidity				
	( )	Free Acidity				
	( )					
	( )					

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 1-13-76

Stream Name(s): Antelope Creek

Source of Sample: Site #2 - above Irwin Ranch

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.29	( )	Manganese
	0.16	( )	Boron		0.002	( )	Mercury
	0.02	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		<0.001	( )	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		0.03	( )	Zinc
	1.0	( )	Fluoride		<0.02	( )	Cyanide
	0.04	( )	Iron (Total)		<0.01	( )	MBAS
	0.0	( )	Iron (Dissolved)		<0.001	( )	Phenol (ppm)
			BOD		0.0	( )	Oil & Grease
			Fecal Coliforms 100 ml		0.0	( )	Sulfides

SPECIAL INSTRUCTIONS

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 1 of 2)

Time Collected _____ Collector Wesche

Date Collected 1-13-76 Facility Name _____

Stream Name(s)
Antelope Creek

Source of Sample: (Exact Location)
Site #3 - above Fiddle Back Ranch on Antelope Creek

Physical Observations, Remarks:	Weather Cond. _____
	Temp. (air) _____ °F
	Ground Cond.

Flow	Field Dissolved Oxygen	Field pH	Field Temp.
0.5 cfs	3.68 mg/1	7.5	0° C,

CATIONS	meq/1	mg/1	(Base Average)	ANIONS	meq/1	mg/1	(Base Average)
Calcium (Ca)	16.97	340		Carbonate (CO_3)	0.00	0.0	
Magnesium (Mg)	13.78	170		Bicarbonate (HCO_3)	8.60	520	
Sodium (Na)	17.45	400		Sulfate (SO_4)	40.68	2000	
Potassium (K)	0.43	17		Chloride (Cl)	0.94	33	
				Nitrate (NO_3)	0.00	0.1	
				*Phosphate(PO_4)as(P)		0.03	
				Fluoride (F)	0.06	1.2	
Total Cations	48.63			Total Anions	50.28		

Values reported are mg/1 unless otherwise stated.

*Not included in Total Anions.

This Test	Base Average		This Test	Base Average	
3570	( )	Conductance(μMHOS)	0.0	( )	Ammonia (N)
22	( )	COD	0.9	( )	Total Kjeldahl (N)
7.7	( )	pH	0.03	( )	Phosphate (PO_4)
54	( )	Turbidity (JTU)	26	( )	Susp. Solids
1500	( )	Hardness	13	( )	Vol. Susp. Solids
433	( )	Alkalinity	3380	( )	TDS
	( )	Total Acidity			
	( )	Free Acidity			
	( )				
	( )				

3410 Total

FOR LAB USE ONLY

Lab Number: _____ Rec'd by: _____

Date sample rec'd: _____ Time: _____

Date analysis completed: _____

Date results forwarded: _____

Total tests requested: _____ Tests run: _____

Lab Section: _____ Supervisor: _____

Transported by: _____ Transported by: _____

Received by: _____ Received by: _____

University of Wyoming - Water Resources Research Institute

Water Analysis Form (Page 2 of 2)

Time Collected: _____

Date Collected: 1-13-76

Stream Name(s): Antelope Creek

Source of Sample: Site #3 - above Fiddle Back Ranch

Special sampling and testing procedures are required for these water tests. Indicate on form if preservative has been added to sample and time tests were completed.

(Values reported are mg/l unless otherwise stated.)

Preservative & Time	This Test	Base Average		Preservative & Time	This Test	Base Average	
	<0.007	( )	Arsenic		<0.1	( )	Lead
	<0.5	( )	Barium		0.14	( )	Manganese
	0.09	( )	Boron		<0.002	( )	Mercury
	0.02	( )	Cadmium		<0.1	( )	Nickel
	<0.01	( )	Copper		<0.001	( )	Selenium
		( )	Chromium (tri)		<0.5	( )	Silver
	<0.1	( )	Chromium (hex)		0.03	( )	Zinc
	1.2	( )	Fluoride		<0.02	( )	Cyanide
	0.84	( )	Iron (Total)		<0.01	( )	MBAS
	0.2	( )	Iron (Dissolved)		0.07	( )	Phenol (ppm)
			BOD		0.1	( )	Oil & Grease
			Fecal Coliforms 100 ml		0.0	( )	Sulfides

SPECIAL INSTRUCTIONS

TABLE 26

LITTLE POWDER RIVER WATER QUALITY DATA

Water Quality Parameter	Unit	4-24-75 Site No. 1	4-24-75 Site No. 2	6-23-75 Site No. 1	6-23-75 Site No. 2	10-8-75 Site No. 1	10-8-75 Site No. 2	1-13-76 Site No. 1	1-13-76 Site No. 2
Calcium	mg/1	85	49	62	72	130	131	150	150
Magnesium	mg/1	44	26	100	84	106	117	98	95
Sodium	mg/1	149	95	180	200	553	753	740	730
Potassium	mg/1	10	8.4	10	9.8	19	17	10	11
Carbonate	mg/1	0	0	0	0	0	0	0	0
Bicarbonate	mg/1	204	122	250	250	415	453	820	790
Sulfate	mg/1	545	312	650	650	1430	1910	1700	1700
Chloride	mg/1	6.2	9.1	67	44	11	18	16	12
Nitrate	mg/1	1	0.9	1.1	1.1	1.0	0.6	0.2	0.2
Fluoride	mg/1	0.1	0	0.4	0.4	1.0	1.2	1.3	1.2
Conductance	µmhos	1319	812	1500	1500	3236	4313	3880	3750
COD	mg/1	46	--	41	36	38	30	26	23
pH	Unit	7.6	7.4	7.6	7.7	8.1	8.3	8.1	8.1
Turbidity	JTU	85	23			9	19	32	22
Hardness	mg/1	394	231	580	530	761	807	770	760
Alkalinity	mg/1	168	100	210	210	317	320	641	621
Ammonia	mg/1	0	0	0	0	0	0	0	0
Total Kjeldahl Nitrogen	mg/1	3	5.9	1.0	1.8	1.1	1.0	0.9	0.7
Nitrite	mg/1					<0.1	<0.1	<0.1	<0.1
Phosphate (PO_4)	mg/1	0.05	0.04	0.04	0.04	0.03	0.05	0.03	0.03
Suspended Solids	mg/1	627	1151	380	444	24	48	21	20
Total Dissolved Solids (TDS)	mg/1	942	562	1203	1194	2830	3540	3220	3090
Total Solids	mg/1	1605	1715	1260	1280	2850	3590	3240	3110
Arsenic	mg/1	0.01	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Barium	mg/1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	mg/1	0	0	0.5	0.2	0.7	0.6	0.19	0.17
Cadmium	mg/1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium (hex)	mg/1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoride	mg/1	0.1	0	0.4	0.4	1.0	1.2	1.3	1.2
Iron (total)	mg/1	1.3	1.6	5.5	1.3	0.8	0.7	0.24	0.28
Lead	mg/1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	mg/1	1.4	1.6	0	0.1	0.06	0.32	0.04	0.14
Mercury	mg/1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002
Nickel	mg/1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	mg/1	0.001	0.002	0.001	0.001	0.001	0.002	<0.001	<0.001

TABLE 26 (Continued)

Water Quality Parameter	Unit	4-24-75 Site No. 1	4-24-75 Site No. 2	6-23-75 Site No. 1	6-23-75 Site No. 2	10-8-75 Site No. 1	10-8-75 Site No. 2	1-13-76 Site No. 1	1-13-76 Site No. 2
Silver	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc	mg/l	0.05	0.02	0.02	0.03	0.13	0.03	0.02	0.02
Cyanide	mg/l	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.02	<0.02
MBAS	mg/l	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Phenol	mg/l	0.003	0.001	<0.001	0.002	0.03	<0.001	<0.001	0.007
Oil and Grease	mg/l	2.1	--	1.9	0.4	0.1	1.0	0	0.3
Sulfides	mg/l					0	0	0	0
Field									
Flow	cfs	8.9	16.2	6.2	7.6	0	0	~0	<1
pH	Unit	8.3	7.9	8.3	8.0	8.0	8.0	7.6-8.0	7.9
Conductance	µmhos	980	630	1320	1500				
DO	mg/l	8.8	9.0	6.2	7.2	5.6	9.3	7.04	6.84
Temperature	°C.	10	14	18	24.5	8.9	13.3	0	0

TABLE 27

ANTELOPE CREEK WATER QUALITY DATA

Water Quality		5-8-75			6-23-75			10-8-75			1-13-76		
Parameter	Unit	Site No. 1	Site No. 2	Site No. 3	Site No. 1	Site No. 2	Site No. 3	Site No. 1	Site No. 2	Site No. 3	Site No. 1	Site No. 2	Site No. 3
Calcium	mg/l	116	126	144	136	140	178	59	196	263	180	240	340
Magnesium	mg/l	42	45	56	51	100	68	37	74	122	68	95	170
Sodium	mg/l	125	137	176	170	180	176	197	173	294	210	190	400
Potassium	mg/l	7.0	8.1	10	8.1	11	12	7.9	14	18	7.4	13	17
Carbonate	mg/l	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate	mg/l	278	235	244	211	280	268	345	456	333	350	380	520
Sulfate	mg/l	486	553	755	730	860	890	474	826	1380	880	1000	2000
Chloride	mg/l	24	47	22	20	56	20	16	21	30	24	17	33
Nitrate	mg/l	0	0.3	0.3	0.2	0.2	0.8	0.2	0.2	0.2	0	0	0.1
Fluoride	mg/l	0	0.3	0.5	0.6	0.7	0.7	1.1	0.9	1.0	1.0	1.0	1.2
Conductance	µmhos	1270	1407	1707	1600	1800	1900	1496	2041	2966	2010	2290	3570
COD	mg/l	16	14	24	47	20	52	28	22	13	16	26	22
pH	Unit	8.1	7.3	8.1	7.9	8.0	8.1	8.3	7.8	8.0	7.8	8.1	7.7
Turbidity	JTU	20	25	42				2.5	54	26		6.5	54
Hardness	mg/l	459	500	592	550	790	730	298	793	1159	710	1000	1500
Alkalinity	mg/l	228	193	200	170	230	220	241	373	271	251	332	433
Ammonia	mg/l	0	0	0	0	0	0	0	0	0	0	0	0
Total Kjeldahl Nitrogen	mg/l	0.6	1.5	1.2	0.7	0.7	1.1	0.7	0.5	0.5	0.5	0.7	0.9
Nitrite	mg/l							<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phosphate (PO_4)	mg/l	0.01	0.01	0.01	0.03	0.02	0.02	0.01	0.04	0.03	0.02	0.02	0.03
Suspended Solids	mg/l	2.5	1.6	3.3	32	192	480	22	126	74	9.9	13	26
Total Dissolved Solids (TDS)	mg/l	938	1033	1285	1220	1502	1476	964	1640	2610	1600	1960	3380
Total Solids	mg/l	947	1048	1353	1210	1580	1700	990	1770	2680	1610	1970	3410

TABLE 27 (Continued)

Water Quality		5-8-75			6-23-75			10-8-75			1-13-76		
Parameter	Unit	Site No. 1	Site No. 2	Site No. 3	Site No. 1	Site No. 2	Site No. 3	Site No. 1	Site No. 2	Site No. 3	Site No. 1	Site No. 2	Site No. 3
Arsenic	mg/1	0.01	0.02	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Barium	mg/1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	mg/1	0	0	0	0.1	0.2	0.3	0.2	0.4	0.1	0.14	0.16	0.09
Cadmium	mg/1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02
Copper	mg/1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium (hex)	mg/1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoride	mg/1	0	0.3	0.5	0.6	0.7	0.7	1.1	0.9	1.0	1.0	1.0	1.2
Iron (total)	mg/1	0.6	1.0	1.3	0.9	0.7	0.4	0.8	2.1	0.7	1.0	0.04	0.84
Lead	mg/1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	mg/1	0.2	0.2	0.2	0.1	0	0	0	0.97	0.13	1.9	0.29	0.14
Mercury	mg/1	<0.001	0.007	<0.001	0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.002	0.002	<0.002
Nickel	mg/1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	mg/1	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001
Silver	mg/1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc	mg/1	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	0.02	0.09	0.03	0.03
Cyanide	mg/1	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.02	<0.02	<0.02
MBAS	mg/1	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenol	mg/1	<0.001	<0.001	<0.001	0.007	0.002	<0.001	0.001	0.08	0.009	<0.001	<0.001	0.07
Oil and Grease	mg/1	1.1	0.1	1.1	0.8	1.5	1.6	0.9	0.7	0.5	0	0	0.1
Sulfides	mg/1							0	0	0	0	0	0
Field													
Flow	cfs	14.1	10.6	9.9	3.08	4.0	6.54	0	0	<1	0	0	0.5
pH	unit	8.2	8.6	8.6	8.2	7.9	8.3	8.0-8.5	8.0	8.0	7.6	7.8	7.5
Conductance	µmhos	910	1150	1225	1480	2040	2000						
DO	mg/1	9.6	8.7	11.4	8.0	6.4	7.6	7.4	4.88	10.4	2.28		3.68
Temperature	°C.	10.0	16.0	10.5	19.0	30.0	29.0	18.3	7.8	6.1	0	0	0

TABLE 28

TABLE OF MAXIMUM, MINIMUM, AND EXPECTED AVERAGE VALUES FOR WATER QUALITY PARAMETERS REPORTED BY FOUR (4) SAMPLING PERIODS AS LISTED IN TABLE 26 FOR THE LITTLE POWDER RIVER

(Data for samples taken between April, 1975 and January, 1976)

		Site No. 1			Site No. 2		
Parameter	Unit	Max.	Min.	Expected Range	Max.	Min.	Expected Range
Calcium	mg/l	150	62	75-150	150	49	40-170
Magnesium	mg/l	106	44	40-110	117	26	20-120
Sodium	mg/l	740	149	175-700	753	95	120-700
Potassium	mg/l	19	10	10-15	17	8.4	10-20
Carbonate	mg/l	0	0	0	0	0	0
Bicarbonate	mg/l	820	204	200-750	790	122	120-700
Sulfate	mg/l	1700	504	700-1600	1910	312	300-1600
Chloride	mg/l	67	6.2	10-50	44	9.1	10-30
Nitrate	mg/l	1.1	0.2	0-2.0	1.1	0.2	0.5-1.0
Fluoride	mg/l	1.3	0.1	0-2.0	1.2	0	0-1.0
Conductance	µmhos	3880	1319	1500-3500	4313	812	900-3900
COD	mg/l	46	26	20-50	36	23	20-30
pH	Unit	8.1	7.6	7.5-8.0	8.3	7.4	7.5-8.0
Turbidity	JTU	85	9	5-90	23	19	10-20
Hardness	mg/l	770	394	400-750	807	231	250-800
Alkalinity	mg/l	641	168	150-600	621	100	150-600
Ammonia	mg/l	0	0	0	0	0	0
Total Kjeldahl Nitrogen	mg/l	3.0	0.9	0.5-3.0	5.9	0.7	0-4.0
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phosphate (PO_4)	mg/l	0.05	0.03	0-1.0	0.05	0.03	0-1.0
Suspended Solids	mg/l	627	21	20-700	1151	20	60-1100
Total Dissolved Solids (TDS)	mg/l	3220	942	900-3000	3540	562	700-3500
Arsenic	mg/l	0.01	<0.007	<0.007	<0.007	<0.007	<0.007
Barium	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	mg/l	0.7	0	<0.9	0.6	0	<0.9
Cadmium	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Iron (total)	mg/l	5.5	0.24	0-7.0	1.6	0.28	0.5-2.0
Iron (dissolved)	mg/l	3.2	0	0-1.5	0.3	0	0-0.5
Lead	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	mg/l	1.4	0	0-2.0	1.6	0.1	0-2.0
Mercury	mg/l	<0.002	<0.001	<0.001	<0.002	<0.001	<0.001
Nickel	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Silver	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc	mg/l	0.13	0.02	0-0.2	0.03	0.02	0-0.05
Cyanide	mg/l	<0.02	<0.008	<0.08	<0.02	<0.008	<0.008
Phenol	mg/l	0.03	<0.001	<0.002	0.007	0.001	<0.01
Oil and Grease	mg/l	2.1	0	0-3.0	1.0	0.3	0-2.0

TABLE 29

TABLE OF MAXIMUM, MINIMUM, AND EXPECTED AVERAGE VALUES
FOR WATER QUALITY PARAMETERS REPORTED BY FOUR (4)
SAMPLING PERIODS AS LISTED IN TABLE 27
FOR ANTELOPE CREEK

(Data for samples taken between May, 1975 and January, 1976)

		Site No. 1			Site No. 2			Site No. 3		
Parameter	Unit	Max.	Min.	Expected Range	Max.	Min.	Expected Range	Max.	Min.	Expected Range
Calcium	mg/l	180	59	40-280	240	126	100-250	340	144	125-350
Magnesium	mg/l	68	37	25-90	100	45	25-150	170	56	40-200
Sodium	mg/l	210	125	100-250	190	137	100-250	400	176	150-450
Potassium	mg/l	8.1	7.0	3-10	14	8.1	5-15	18	10	5-20
Carbonate	mg/l	0	0	0	0	0	0	0	0	0
Bicarbonate	mg/l	350	211	150-400	456	235	200-500	520	244	200-500
Sulfate	mg/l	880	474	350-950	1000	553	450-900	2000	755	800-1800
Chloride	mg/l	24	16	10-30	56	17	20-70	33	20	20-30
Nitrate	mg/l	0.2	0	0-1	0.3	0	<1.0	0.8	0.1	<1.0
Fluoride	mg/l	1.1	0	0-2	1.0	0.3	<1.0	1.2	0.5	0-1.8
Conductance	µmhos	2010	1270	1000-2500	2290	1407	1400-2300	3570	1707	1700-3200
COD	mg/l	47	16	10-50	26	14	10-25	52	13	10-40
pH	Unit	8.3	7.8	7.0-8.5	8.1	7.3	7.0-8.5	8.1	7.7	7.5-8.1
Turbidity	JTU	20	2.5	10-180	54	6.5		54	26	20-50
Hardness	mg/l	710	298	400-800	1000	500	500-1100	1500	592	600-1400
Alkalinity	mg/l	251	170	150-300	373	193	200-400	433	200	200-400
Ammonia	mg/l	0	0	0	0	0	0	0	0	0
Total Kjeldahl Nitrogen	mg/l	0.7	0.5	0-1.5	1.5	0.5	0.5-2.0	1.2	0.5	0.5-1.5
Nitrite	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phosphate (PO_4)	mg/l	0.03	0.01	<0.5	0.04	0.01	<1.0	0.03	0.01	0-0.03
Suspended Solids	mg/l	32	2.5	10-150	192	1.6	20-250	480	3.3	70-300
Total Dissolved Solids (TDS)	mg/l	1600	938	800-2000	1960	1033	1100-2200	3380	1285	1400-3000
Arsenic	mg/l	0.01	<0.007	<0.01	0.02	<0.007	<0.007	<0.007	<0.007	<0.007
Barium	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	mg/l	0.2	0	0-0.2	0.4	0	<0.5	0.3	0	<0.5
Cadmium	mg/l	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.02	<0.01	<0.01
Copper	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Iron (total)	mg/l	1.0	0.6	0-2.0	2.1	0.04	0.5-2.0	1.3	0.4	0.5-2.0
Iron (dissolved)	mg/l	3.2	0	0-1.0	0.1	0	0-0.5	0.2	0.1	0-0.5
Lead	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Manganese	mg/l	1.9	0	0-3	0.97	0	0-1.0	0.2	0	0-0.03
Mercury	mg/l	0.002	<0.001	<0.001	0.007	<0.001	0-0.007	<0.002	<0.001	<0.001
Nickel	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Silver	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc	mg/l	0.09	<0.02	<0.02	0.03	<0.02	<0.02	0.03	<0.02	<0.02
Cyanide	mg/l	<0.02	<0.008	<0.008	<0.02	<0.008	<0.008	<0.02	<0.008	<0.008
Phenol	mg/l	0.007	<0.001	<0.001	0.08	<0.001	<0.002	0.07	<0.001	<0.001
Oil and Grease	mg/l	1.1	0	0-2.0	1.5	0	0-3.0	1.6	0.1	0-2.0

CHAPTER V

DISCUSSION

The aquatic fauna collected in the Little Powder River and Antelope Creek can generally be classified as cool and warmwater forms which are quite tolerant of the rather harsh environmental conditions provided by the streams. Both are low-gradient, shallow, sluggish habitats characterized by vast fluctuations in flow (0 to 16,000 cfs on the Cheyenne River below the Antelope Creek sites and 0 to 1,000 cfs on the Little Powder), temperature (0 to 30°C), turbidity (up to 1,500 JTU measured on Little Powder in 1974) and dissolved oxygen (down to 2.28 mg/1 at Antelope Creek in January, 1976). Also, the substrates of both are composed almost entirely of sand and silt, and appear to be very shifting in nature.

The fish fauna on both study streams is predominated by an assemblage of cyprinid (minnow) species, including sand shiners, fathead minnows, plains minnows and flathead chubs, with lesser numbers of carp and longnose dace. On Antelope Creek, plains killifish were also abundant. Neither stream can be considered a viable sport fishery, as the only game-fish species collected were black bullheads and green sunfish, both present only in small numbers and smaller sizes. Due to their tolerances of high water temperatures (many can survive up into the 30° to 34°C range) and low dissolved oxygen concentrations (down to 2 mg/1) these species can survive, even in shallow, stagnant pools during intermittent periods (Brett, 1956; Jones, 1964).

The most abundant members of the bottom fauna collected in the Little Powder River and Antelope Creek were Diptera larvae (primarily Chironomus and Pentaneura), beetle larvae (Dubiraphia), freshwater snails (Physa and Lymnaea), clams (Sphaerium), oligocheates and mayfly nymphs (Caenis). These invertebrates are commonly found living in or near the mud substrates of ponds, lakes and streams where they feed primarily upon organic debris (Usinger, 1973; Hynes, 1970; Pennak, 1953). Noticeably absent, or present only in very low numbers, were representatives of the orders Plecoptera (stoneflies) and Trichoptera (caddisflies) and other families of mayflies which require stream locations having higher water velocities and larger substrate sizes than were present at the study sites.

Community diversity at the Little Powder River and Antelope Creek sites, as measured by the Shannon Diversity Index, was quite low, with all mean values falling well below 1.0. Mangum (1975) states that in communities of macroinvertebrates, it is natural to find a few species with high numbers of individuals and many species with a few individuals. The effects of an unfavorable condition are often manifest by elimination of some species, a reduction in numbers of other species, and/or an increase in numbers of one to several species which proliferate due to an absence of competition and an abundance of food. In his work, Mangum has described as "poor" those macroinvertebrate communities where diversity values are less than one. Due to the harsh natural environments of the Little Powder and Antelope Creek (i.e., intermittency, high temperatures and turbidities, low dissolved oxygen, and low habitat diversity in terms of substrate, water depths and velocities), it is understandable that the diversity of the invertebrate communities is not higher.

In the 1975 samples at the Little Powder River sites, both the relative abundance and the diversity of the bottom fauna were found to range higher than those of 1974, as reported by Wesche, Kerr and Baldridge (1975). The low 1974 values were at least partially attributed to the deleterious effects which the high turbidities had on the growth of aquatic vegetation, a source of both food and shelter for invertebrate life. While nutrient levels in 1975 remained at 1974 levels, turbidities ranged lower. This allowed increased light penetration and subsequently, the increase in aquatic vegetation that was noted at the study sites. It would appear then that this additional habitat was, in part at least, responsible for the higher invertebrate densities and diversities observed.

The purpose for including water quality determinations with this study has been to define baseline, predevelopment conditions in the Little Powder River and Antelope Creek and, in conjunction with the sampling of the aquatic biota, to allow for assessments to be made of the impacts which increasing industrial developments in these basins may have in future years.

At all sites investigated, sulfate was the predominant anion, often comprising over 60 percent of the total anion activity in the sampled waters. Sulfate-containing minerals are commonly found in the region and include epsomite gypsum and baulurite (USDI, 1974). The predominant cationic components of these minerals are magnesium, calcium and sodium, respectively. These cations were found to exhibit approximately equal activities in the waters sampled suggesting a geochemical rather than man-made explanation for the observed water quality conditions.

By site, these waters could be generally categorized in the following manner.

Little Powder River

- Salt concentration inversely related to flow during runoff events. During no flow, concentrative effects in downstream direction increase salt loads.
- Presence during runoff of reduced nitrogen compounds, indicating a possible field wash of fecal material.
- Generally low levels of trace metals. One zinc sample exceeded the recommended "threshold concentration" of 0.1 mg/l (0.13). No other examples of concern.
- Phenol concentrations were found in excess of USPH standards. Currently, it is not known if this is a reliable figure as other data exist to suggest an invalidity of technique.
- Moderate COD levels (23-46) were observed. These are not considered extreme but are generally higher than those observed in the Antelope Creek investigation.
- High suspended solids (in excess of 1,100 mg/l) during runoff. This condition is common in the Powder River main stem and its tributaries.
- Low nutrient levels were found within the study area. Insufficient time and/or availablility of the reduced nitrogen for oxidation is assumed.

Antelope Creek

- Increasing mineralization in a downstream direction. No significant change is observed in chemical relationships between sites

indicating that the factors influencing concentration are constant throughout the study area.

- Low levels of trace metals and elements.
- Low concentrations of oil and grease.
- Low levels of reduced nitrogen and carbonaceous material. Insignificant phosphate and nitrate concentrations were found.
- Strong water quality similarities to other drainages in the Eastern Powder River Basin (USGS, 1974).

CHAPTER VI

SUMMARY AND RECOMMENDATIONS

1. The aquatic biota and abiota of the Little Powder River and Antelope Creek on Thunder Basin National Grassland have been monitored quarterly during 1975 to determine baseline conditions prior to development of mineral resources in the basins. This constituted the second year of study on the Little Powder under the SEAM Program, the first for Antelope Creek.

2. Through Thunder Basin, both study streams are relatively shallow, meandering, low-gradient rivers characterized by wide pastoral floodplains dotted with cottonwood trees, intermittency, substrates primarily of sand and muck, and high summer water temperatures. The Little Powder River, located in Campbell County, drains approximately 550 square miles of land in the Powder River Basin above the reaches studied. Antelope Creek, the headwaters of the Cheyenne River (tributary of the Missouri River), is located in Converse and Campbell Counties and has a watershed covering 1500 square miles above the study sites. Both basins have low drainage densities (Little Powder River, 0.85; Antelope Creek, 0.99). Relatively undeveloped sub-bituminous coal deposits underlay each drainage. In the Little Powder Basin, both the AMAX Coal Company and the Carter Oil Company are presently initiating mining efforts, although production has not yet begun. The Peabody Coal Company controls leases in the Antelope Creek Basin which are currently undeveloped.

3. The fish fauna of both study streams is predominated by an assemblage of cyprinid (minnow) species, including sand shiners, fathead minnows, plains minnows and flathead chubs, with lesser numbers of carp and longnose dace. On Antelope Creek, plains killifish are also abundant. Neither stream can be considered a viable sports fishery, as the only game fish species collected were small numbers of green sunfish and black bullheads. Overall, the fish species present are cool and warmwater forms which are quite tolerant of a wide range of environmental conditions. No species classified as "Rare and Endangered" were collected in the 1975 samples.

4. The invertebrate communities sampled are characterized by low diversity and generally large seasonal variations in relative abundance. The predominant forms collected were Diptera larvae, beetle larvae (Dubriaphia sp.) freshwater snails, clams, oligocheates, and mayfly nymphs (Caenis sp.). Seasonally, the trend is for lowest abundance and diversity in the spring or early summer, with increases noted in the fall and winter samples. For the Little Powder River, abundance and diversity ranged somewhat higher in 1975 than in 1974. This coincided with an increase noted in

aquatic vegetation due, at least in part, to decreased turbidities in 1975.

5. The water quality data presented in the various tables and forms generally corroborates data collected at other ongoing Eastern Powder River Basin water quality studies. These waters contain sodium, calcium, and magnesium in equal amounts with sulfate and to a significantly lesser degree bicarbonate to form a moderately mineralized, well buffered, hard water. The presence of nutrients and reduced organics results from the current land use practices. No significant problems were indicated during this current program. Trace elements were shown to exist but in concentrations considered insignificant. Any alternatives in the levels of these substances will result from an alternation of land use practices.

6. It is the recommendation of the Principal Investigators that quarterly sampling of water quality and benthic fauna be continued on the Little Powder River (Sites 1 and 2) and Antelope Creek (Sites 1 and 3) to further identify baseline conditions and to begin to assess the impacts of the upstream development currently being initiated. Care should be taken to gather samples on or very near the dates of the 1975 collections, thus allowing more accurate comparisons to be made between sampling years. Fish populations should be sampled at least once during the year, preferably in the early summer. Due to its periodic tendency to go completely dry, it is recommended that Antelope Creek Site No. 2 be discontinued.

CHAPTER VII

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